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STOPPING WATER POLLUTION AT ITS SOURCE

MISA

Municipal/Industrial Strategy for Abatement

The Draft Development Document

for the

Effluent Limits Regulation

for the

Metal Mining Sector

ISBN 0-7778-1119-7

THE DRAFT DEVELOPMENT DOCUMENT

FOR THE EFFLUENT LIMITS REGULATION

FOR THE METAL MINING SECTOR

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EXECUTIVE SUMMARY

The Regulation Requires:

- A process effluent pH at all times of 6.0 to 9.5
- Effluents that are non-toxic to Rainbow Trout and Daphnia magna
- Monitoring of Cooling Water and Emergency Overflow Effluents
- A prohibition of by-passes
- Limits for Process Effluents as follows:

Parameter	Monthly Average Concentration mg/litre	Daily Concentration mg/litre
Total Cyanide	1	2
Total Suspended Solids	15	30
Arsenic	.5	1
Copper	.3	.6
Nickel	.5	1
Lead	.2	.4
Zinc	.5	1

Main Features of the Regulation:

- Applies to existing and new operating metal mines in Ontario

"mine" means any opening or excavation in, or working of the ground, for the purposes of winning any metal, mineral or mineral-bearing substance, and all ways, works, machinery, plant, buildings and premises below or above ground belonging to or used in connection with such activity, and any roasting or smelting furnace, concentrator, mill, work or place used for or in connection with washing, crushing, grinding, sifting, reducing, leaching, roasting, smelting, refining, or treating of such substances

"operating metal mine" means a mine that is in commercial production of a metal or combination of metals, or a metal-bearing substance or a combination of metal-bearing substances for either immediate sale or stockpiling for ultimate sale

"metal" means copper, nickel, lead, zinc, gold, silver, iron or uranium, or any combination thereof

- **Applies only to existing and new operating metal mines that discharge a daily plant volume greater than 50 cubic meters**

  "daily plant volume" means the sum of the volumes of all process effluent monitoring streams, cooling water effluent monitoring streams and emergency overflow effluent monitoring streams at the plant for an operating day

- **Limits are stated in terms of concentrations**

  loadings must be calculated and reported

PREFACE

The Municipal/Industrial Strategy for Abatement (MISA) program is Environment Ontario's program to reduce the discharge of toxic contaminants to Ontario's waterways. Under the first phase of MISA, dischargers were required to monitor and report on the contaminants present in their effluent streams. This information has subsequently been used to set legal discharge limits requiring reductions in toxic discharges to the level attainable with the best available pollution control technology which is economically achievable. The ultimate goal of the MISA program is the virtual elimination of persistent toxic contaminants from all discharges into Ontario's waterways.

This document contains all the legal effluent discharge requirements for Ontario's MISA Metal Mining Sector. These requirements are specified in "Ontario Regulation (?)/93: Effluent Limits-MISA Metal Mining Sector". The regulation is issued under the Ontario Environmental Protection Act (Section 136).

"Ontario Regulation (?)/93: Effluent Limits-MISA Metal Mining Sector" states the quality discharge limits, toxicity testing, flow measurement and reporting requirements that each direct discharge operating metal mine must meet. The Regulation comes into force on (?), 1996, allowing existing operating metal mines a period of three (3) years within which to implement pollution control strategies and install those capital works necessary to meet the effluent limits.

Ontario Regulation (?) /93 states that sampling points must be established at each operating metal mining site on every process effluent monitoring stream, on every cooling water stream and on every emergency overflow effluent stream. Routine monitoring requirements, designed to provide the Ministry of the Environment with assurance that the operating metal mines are meeting the regulation requirements, are tabulated in accompanying schedules.

This document includes six chapters.

CHAPTER ONE of this document is introductory and presents the environmental background to MISA and the main features of the program. A description of the Effluent Monitoring Regulation for the Metal Mining Sector is given and the generic effluent limits regulation development process is explained.

CHAPTER TWO presents information about the MISA Metal Mining Sector. The sector consists of approximately 50 metal mines. The metals most commonly recovered from Ontario ores at the present time are copper, nickel, lead, zinc, silver and gold. Chapter two also includes a brief account of the chemical composition of effluents from Ontario metal mines and discusses the various waste treatment strategies used in the treatment of these effluents.

CHAPTER THREE contains information about the effluent monitoring data used in the development of the effluent limits. The chapter includes a summary of the data collected under the one-year regulated MISA effluent monitoring program. The complete MISA effluent monitoring database has been published as a separate report entitled "Status Report: The Metal Mining Sector Effluent Monitoring Data: For the Period February 1, 1990 to January 31, 1991: October, 1992". Data validation, candidate parameter selection and QA/QC data assessment are also discussed in this chapter.

CHAPTER FOUR describes the assessment of available pollution control technologies for the control of metal mining effluents and describes the identification of those technologies considered to be the "best available". Chapter four also examines the economic and financial implications of each of the "best available" technology (BAT) train options and presents a summary of the likely impact of each BAT option on the sector.

CHAPTER FIVE presents the effluent limits and describes the limit development process. Existing control requirements are also reviewed along with those from other jurisdictions.

CHAPTER SIX presents a summary of the key components of the Effluent Limits Regulation for the MISA Metal Mining Sector. Compliance requirements and monitoring frequencies are defined as are other regulation requirements such as toxicity testing criteria and flow measurement accuracy.

This document and the associated limits regulation, database and Best Available Pollution Control Technology report represents the culmination of over six years of effort on the part of the Provincial and Federal governments, industry and the public. The public review process was a key component in the development of the Effluent Limits Regulation for the Metal Mining Sector. The draft version of the regulation was released for public review on (?),

1993. In addition to the public review, the regulation was reviewed by the MISA Advisory Committee, which is a committee made up of environmental experts external to the Ministry who provide advice directly to the Minister on the contents of the MISA regulations.

The MISA Initiative

Chapter One

of the

Development Document

THE MISA PROGRAM

The MISA program was officially announced by the Ontario Ministry of the Environment in the White Paper of June 1986. MISA is a regulatory program for reducing water pollution from both industrial and municipal dischargers. Initially, technology-based effluent limits are imposed on each discharger as a minimum pollution control requirement. In addition, more stringent effluent limits can be imposed on dischargers on a site-specific basis to protect local sensitive receiving waterbodies. The ultimate goal of MISA is the virtual elimination of persistent toxic contaminants from all discharges into Ontario's waterways.

The process to develop technology-based limits involves two phases. In the first phase, effluent monitoring regulations are legislated which require dischargers to monitor their point source effluents at regular intervals according to specific sampling, analytical, flow measurement and quality assurance and quality control protocols and procedures. The second phase involves the development and implementation of effluent limits regulations for each of the industrial and municipal sectors using the data collected under the monitoring regulations.

The MISA effluent monitoring and limits regulations initially involve all major dischargers , on a sector-by-sector basis, that discharge directly into Ontario's waterways. Industrial dischargers in the following sectors are included:

- petroleum refining
- organic chemical manufacturing
- iron and steel
- metal mining
- pulp and paper
- inorganic chemical manufacturing
- metal casting
- electric power generation
- industrial minerals

Note: The above group accounts for approximately two-thirds of Ontario's direct industrial dischargers; the remaining dischargers are to be covered as other sectors are brought under regulation.

The Effluent Monitoring Regulations required dischargers to monitor their point source discharges at regular intervals. This monitoring was intended to provide comprehensive data on effluent quality, particularly for toxic contaminants. In order to accurately reflect all discharger operating conditions, the effluent monitoring regulations required sampling at various frequencies over an entire 12-month period using specified standard procedures. Industry's self-monitoring under the regulations was subject to independent audits carried out by the Ministry of the Environment.

Information generated by the effluent monitoring regulations

produced a database on the contaminants discharged across Ontario. This database is being evaluated and used in development of effluent limits based on the best available pollution control technology which is economically achievable (BATEA).

The Effluent Limits Regulations are being developed in consultation with different levels of government, industry and the general public. Consultation is facilitated through a Joint Technical Committee (JTC) made up of representatives from the Ministry, Environment Canada, the affected dischargers and other stakeholders. The JTC (one per sector) provides an opportunity for the dischargers to have input into the regulation development process.

Review of the draft regulations is initially provided by the MISA Advisory Committee (MAC) which is an independent committee of technical and environmental experts that provides the Minister of the Environment with advice and comments on the development and implementation of the MISA program. All regulations appear in draft form for a specified period, prior to promulgation, to allow for public review and comment.

Development of the Effluent Limits Regulations does not end with the promulgation of the last sector regulation. The Ministry is committed to keeping abreast of available pollution reduction technology. As such, the Effluent Limits Regulations will be reviewed and, if technology emerges which allows the imposition of more stringent effluent limits on a particular sector, the sector regulation will be amended to reflect those limits.

Through this process of ongoing evaluation and step-by-step reductions, MISA's ultimate goal to virtually eliminate the discharges of toxic contaminants will be achieved. Such a goal fulfils Ontario's commitment to the protection and improvement of our natural water resources and is consistent with the provisions of the Canada-Ontario Agreement Respecting Great Lakes Water Quality and the Canada-United States Great Lakes Water Quality Agreement.

THE EFFLUENT MONITORING REGULATIONS

The MISA Monitoring Strategy

A large number and variety of chemicals are manufactured and used in today's industrial society. During the development of the Effluent Monitoring Regulations, the Ministry realized that a system was required to evaluate the chemicals to be monitored by each industrial sector. The Ministry also realized that it would be necessary to limit the number of allowable monitoring techniques in order to provide a common scientific basis for comparison of data from sector-to-sector and from site-to-site.

The Ministry developed a monitoring strategy based on:

- the Effluent Monitoring Priority Pollutants List (EMPPL) which identifies toxic contaminants of concern

- voluntary pre-regulation effluent monitoring which facilitated the identification of the specific chemicals to be monitored, their monitoring frequency and the appropriate techniques for chemical analysis

THE EFFLUENT MONITORING PRIORITY POLLUTANT LIST

The Effluent Monitoring Priority Pollutant List (EMPPL) is a dynamic list containing the names of those contaminants potentially present in industrial and municipal discharges which could pose a hazard to the receiving environment. In order to initiate and maintain such a list, the Ministry developed a "hazard assessment" process which evaluated, for a particular contaminant:

- potential presence in effluents discharged to Ontario's waterways
- environmental persistence
- potential to bioaccumulate
- acute and sub-lethal toxicity to biological organisms, including humans, as measured by specific indicators of toxicity such as the ability to induce tumours and affect successive generations

Initial efforts resulted in EMPPL containing 183 chemicals or groups of chemicals. The hazard assessment process is ongoing. The current EMPPL contains approximately 266 chemicals or groups of chemicals.

Chemicals not on the current EMPPL but identified through open scan characterization are candidates for assessment and, possibly, inclusion on EMPPL. Chemicals may also be added to EMPPL based on new environmental fate or toxicity information. Although initiated as part of the initial MISA monitoring strategy, EMPPL will be used on an ongoing basis for the development of MISA Effluent Limits Regulations.

PRE-REGULATION EFFLUENT MONITORING

Pre-regulation effluent monitoring was undertaken voluntarily by representative industrial dischargers in each sector to provide an initial database on which to build the sector-specific requirements for the Effluent Monitoring Regulations. Pre-regulation effluent monitoring included:

- the collection of information covering several areas of plant operations . This included process descriptions, raw material use, sewer diagrams and effluent treatment

information
- site visits by multi-disciplinary teams to inspect on-site operations, general environmental control practices and sampling and flow monitoring locations
- effluent monitoring studies using sampling and analytical protocols provided by the Ministry
- technical reviews of other available databases
- development of sector-specific monitoring lists based on EMPPL and pre-regulation effluent monitoring data

Upon completion of the pre-regulation effluent monitoring, the Ministry developed sector-specific effluent monitoring regulation requirements.

PRINCIPLES OF THE EFFLUENT MONITORING REGULATIONS

In designing the Effluent Monitoring Regulations, every effort was made to ensure that the information gathered under the regulations would provide an accurate characterization of effluent quality. The monitoring program was therefore designed to ensure that the following conditions were met:

- The monitoring data would be of known and acceptable quality. The requirements specified in the MISA effluent monitoring regulations were designed to ensure acceptable data quality. A system of procedures and documentation was prescribed for all monitoring activities including sampling techniques, sample preservation, analytical procedures, flow measurement and data reporting. In addition, the regulations prescribed the minimum amounts of QA/QC data that were to be generated and the terms and conditions under which such data were to be reported to the Ministry.

- The monitoring data would reflect effluent variability. Dischargers were required to monitor during all operating conditions, including normal and upset conditions, in all seasons of the year.

- The monitoring data would be of sufficient volume to provide a statistically valid database for the development of effluent limits.

EFFLUENT STREAMS MONITORED

The MISA Effluent Monitoring Regulations required direct dischargers to monitor all point source discharges of pollution entering surface watercourses including process effluents, cooling water effluents, storm water effluents, backwash effluents, emergency overflow effluents and waste disposal site effluents.

MONITORING FREQUENCIES

The Ministry's approach to monitoring reflected both the need for a comprehensive database and the limitations imposed by practical considerations including cost. Frequent monitoring (daily, thrice weekly, weekly) was required for a short list of parameters while less frequent monitoring (monthly, quarterly, semi-annually and annually) was required for a longer list of parameters.

SAMPLING REQUIREMENTS

To ensure that data of proven quality would be obtained from the samples collected during monitoring, sample collection and preservation needed to be rigorously controlled.

Whenever possible, sampling of process effluents was required prior to dilution by other waste streams. Sample collection methods included automatic sampling, flow-proportional sampling and grab sampling.

Sample preservation protocols were specified for all parameters that were susceptible to degradation through chemical, biological or physical interaction. These protocols ranged from the addition of a chemical preservative to simple refrigeration and storage criteria.

FLOW MEASUREMENT

The effluent monitoring regulations specified that flow measurement readings were to be taken accurately on a continuous basis or at least at the time of sampling.

To ensure that flow measurement readings were precise and representative, the regulation specified the frequency and defined the acceptable limits of accuracy for flow measurement on each type of stream.

ANALYTICAL REQUIREMENTS

Analytical principles were provided for the analysis of all samples. Adherence to these principles was required in order to ensure that the data generated would be reliable, of consistent quality, and sufficiently compatible to be integrated into a valid and meaningful database.

Under the effluent monitoring regulations, laboratories were required to provide the analytical detection limit (MDL) for each parameter before the samples could be analyzed. The MDL is the minimum concentration of a parameter necessary to imply its presence in a sample with a level of confidence that is greater than 99 per cent. The procedures for determining analytical detection limits are provided in the Ministry publication titled "Estimation of Analytical Detection Limits" (ISBN 0-7729-4117-3).

TOXICITY TESTING

Toxicity testing was used to assess the potential impact of complex effluents on the aquatic environment. Two types of toxicity tests were required under the Effluent Monitoring Regulations for each sector:

- Rainbow Trout Acute Toxicity Test. This test is the standard fish lethality test in Ontario; an effluent is considered acutely lethal if 50% or more of the rainbow trout die when kept in undiluted effluent for a period of 96 hours (4 days).

- Daphnia magna Acute Lethality Test. In this test, an effluent is considered acutely lethal if 50% or more of the Daphnia magna die when kept in undiluted effluent for a period of 48 hours (2 days).

REPORTING

The Effluent Monitoring Regulations required direct dischargers to report to the Ministry all of the effluent monitoring data collected under the regulations. The reporting section of each sector-specific regulation specified report type, content, timing and format.

MINISTRY AUDIT

Audits were conducted by the Ministry to confirm that the self-monitoring data reported by direct dischargers was representative of the quality and quantity of effluent discharged to the environment.

ENFORCEMENT

Failure to comply with the requirements of the Effluent Monitoring Regulations was considered to be a violation of the Environmental Protection Act.

THE GENERAL EFFLUENT MONITORING REGULATION

Under MISA, the monitoring requirements for each industrial sector were outlined in a general effluent monitoring regulation and a sector-specific regulation. The general effluent monitoring regulation, Ontario Regulation 695/88 as amended to Ontario Regulation 533/89, expressed the technical and scientific principles of monitoring that were common to all sectors. The sector -specific regulations stated how the monitoring principles should be applied to plants in those particular sectors.

The general effluent monitoring regulation describes sampling and analytical requirements, flow measurement requirements and toxicity testing and reporting procedures.

The sector-specific effluent monitoring regulations list the effluent streams and parameters to be monitored at each plant and the monitoring frequencies. Plant specific and sector specific requirements for characterization analysis, routine chemical monitoring, toxicity testing, flow measurement and reporting are also listed.

THE EFFLUENT MONITORING REGULATION FOR THE MISA METAL MINING SECTOR

The Effluent Monitoring Regulation for the MISA Metal Mining Sector was designed to provide an accurate account of the discharge of priority and traditional pollutants by the Ontario metal mining industry.

The regulation was developed by the Ministry in consultation with representatives of the Ontario metal mining industry, MISA Advisory Committee, Ontario Ministry of Northern Development and Mines, Atomic Energy Control Board and Environment Canada. All of the above were members of the MISA Metal Mining Sector Joint Technical Committee (JTC).

The specific requirements of the Effluent Monitoring Regulation for the Metal Mining Sector are presented in Ontario Regulation 491/89 as amended to Ontario Regulation 44/90. A detailed explanation of the rationale behind the specific requirements is presented in the Development Document for the regulation.

THE EFFLUENT LIMITS REGULATION DEVELOPMENT PROCESS

Effluent Limits Regulations are being imposed on each of the MISA industrial sectors. The Effluent Limits Regulation for the Metal Mining Sector will regulate all existing and new operating metal mines in the Province of Ontario.

The Effluent Limits Regulations are being developed at the sectorial Joint Technical Committee level with input from the MISA Advisory Committee and all stakeholders.

The process which was followed in developing the Effluent Limits Regulation for the Metal Mining Sector was initially outlined in the MISA White Paper. Each step is briefly described as follows:

Effluent Monitoring

Under the Effluent Monitoring Regulation, direct dischargers were required to monitor for a comprehensive list of parameters.

Up to 150 parameters were monitored on a thrice weekly, monthly, quarterly or annual basis. Process effluents, minewater effluents, smelter-refinery effluents and stormwater effluents were monitored.

Data Validation

The effluent monitoring data were subject to a rigorous data validation exercise in order to confirm the integrity of the information contained in the effluent monitoring database.

Candidate Parameter Selection

Statistical tests were applied to the effluent monitoring data to determine candidate parameters for effluent limits setting. Parameters were not considered if the effluent monitoring data showed (at a 95% confidence level) that a statistical portion of 0.9 of the data were at a concentration of less than the regulation method detection limit (RMDL).

QA/QC Data Assessment

The quality assurance/quality control (QA/QC) data assessment evaluated the suitability of the effluent monitoring data for use in the effluent limits setting process. Data which were considered to be unreliable were eliminated from further consideration in the effluent limit setting process.

Available Technology Identification

Available pollution control technologies were identified and evaluated. The technologies were screened on the basis of the number, kind and toxicity of the contaminants treated and the contaminant reductions achieved.

BAT Identification

Best available technologies were identified and BAT technology train options representing different levels of pollution control and abatement were determined. BAT technology train options were reviewed in order to identify the contaminants that would be treated if the options were installed at Ontario metal mines, the costs of installing each option and the contaminant discharge levels that would result.

Economic Assessment

Information about estimated pollutant removal efficiencies and the costs of the various BAT technology train options was used to derive abatement cost functions which indicated the relationship between increasingly stringent levels of control and the costs of achieving them. The economic impact on the Ontario metal mining industry of the various levels of control was also estimated.

BAT(EA) Identification

The information on the identified BAT technology train options and the economic and financial impacts of each option on the metal mining sector were used to determine the "best available technology economically achievable" (BATEA) upon which the effluent limits were based.

Effluent Limits Setting

Effluent limits were developed based on the identified BAT(EA) and the best professional judgement (BPJ) of the Ministry, industry and other stakeholders.

THE EFFLUENT LIMITS REGULATION

In addition to the effluent limits developed using the above process, the effluent limits regulation contains requirements for toxicity testing. Toxicity testing requirements stipulate when and how dischargers must test their effluents.

Flow measurement requirements are also included in the limits regulation. Pollutant loadings are determined by multiplying the concentration of the contaminants in the effluent by the rate at which the effluent is discharged (and applying additional factors to convert the loadings into the units desired). The accuracy of the derived pollutant loadings depends, in part, on the accuracy of the device that is used to measure the flow. Therefore, a level of accuracy for flow measuring devices was set and dischargers must ensure that their equipment is designed and maintained to achieve the required level of accuracy.

The effluent limits regulation stipulates that direct dischargers must comply with the requirements of the regulation. The regulation sets out the terms and conditions of compliance. These terms specify what the dischargers must do in order to demonstrate that the regulation requirements are being met.

The frequency of contaminant monitoring for the purpose of assessing compliance with the effluent limits is a main component of the regulation compliance requirements. Information gained through compliance monitoring will provide the Ministry, the public and all stakeholders with information on the effectiveness of the MISA program.

The Ministry is committed to reporting to the public information such as which dischargers are not in compliance, which dischargers have to implement further pollution controls and the status of individual abatement programs. Reports will also indicate progress toward achieving the MISA goal of virtual elimination of persistent toxic substances.

The effluent limits regulations will be periodically reviewed and, if new economic technology emerges which could reduce contaminant levels below those imposed by the current limits, the regulations can be revised to reflect the more stringent limits.

REFERENCES

- Ontario Ministry of the Environment (1986). "Municipal-Industrial Strategy For Abatement (MISA). A Policy And Program Statement Of The Government Of Ontario On Controlling Municipal and Industrial Discharges Into Surface Waters"

- "Canada-Ontario Agreement Respecting Great Lakes Water Quality" (signed March 6, 1986)

- International Joint Commission (1978). "Great Lakes Water Quality Agreement, With Annexes and Terms Of Reference Between The United States And Canada"

- Ontario Ministry of the Environment (1987). "The Effluent Monitoring Priority Pollutants List".
  ISBN 0-7729-2784-7

- Ontario Ministry of the Environment (1989). "Estimation Of Analytical Method Detection Limits (MDL)".
  ISBN 0-7729-4117-3

- Government of Ontario (1988). "Ontario Regulation 695/88 As Amended To Ontario Regulation 533/89 Under The Environmental Protection Act--Effluent Monitoring--General"

- Government of Ontario (1990). "Ontario Regulation 491/89 As Amended To Ontario Regulation 44/90 Under The Environmental Protection Act--Effluent Monitoring--Metal Mining Sector"

- Ontario Ministry of the Environment (1989). "The Development Document For The Effluent Monitoring Regulation For The Ontario Metal Mining Sector"
  ISBN 0-7729-5227-2

The Industrial Sector

Chapter Two

of the

Development Document

SECTOR OVERVIEW

GENERAL INDUSTRY PROFILE

The Canadian Shield is one of the largest and richest mining areas in the world. A large portion of the Shield lies within the boundaries of the Province of Ontario.

Metal mining operations in Ontario follow two basic patterns: open pit and underground. Of the two, underground operations predominate. It is not unusual, however, for open pit mining to precede conventional underground mining at any particular property providing that the geology and ground conditions are suitable.

There are standard mining procedures but the varying shapes of orebodies and changeable geology result in no two mines ever being exactly the same.

Mines range all the way from the early prospect which may have only a single level with limited lateral workings to the deep and complex workings of mines that have been in production for many years. Many Ontario mines reach depths of over 1 kilometer and many Ontario mines have more than 100 kilometers of workings underground.

Mines around the world produce almost identical products. Competition is intense. In addition, ore reserves at any property are finite and largely determine how long a property can be operated. With relatively short lives when compared to other industries, mines are forced to adopt or adapt technology that is available, economic and competitive on a global basis.

This report is based on the Ontario Metal Mining Sector as it existed from February 1, 1990 to January 31, 1991. At that time, the Sector consisted of over 40 metal mining properties. This total included 3 inactive properties with operating mechanical treatment systems. The data in this report are based on approximately 50 direct discharges to the environment.

During the period February 1, 1990 to January 31, 1991, the Ontario Metal Mining Sector processed approximately 100,000 tonnes of ore per day and discharged approximately 695,000 cubic meters (153,000,000 gallons) of wastewater per day.

A summary of flow data (cubic meters per day) for all plants monitored in the metal mining sector is given in the following table (N=number of samples; CV=stand. deviation/mean):

Summary of Flow Data (m3/day)
MISA Metal Mining Sector

12-Month Monitoring Data
February 1, 1990 to January 31, 1991

Company	CtrlPt.	N	Minimum	Median	Maximum	Mean	CV	Standard Deviation
01 – INCO, Copper Cliff T.P.	PR 0100	156	24,000.000	103,450.000	203,200.000	101,443.141	34.3	34838.6
02 – INCO, Crean Hill Mine	MW 0100	157	381.000	2,132.000	16,125.000	2,566.783	77.7	1993.5
03 – Falconbridge, Falconbridge	PR 0100	157	206.430	23,100.580	79,424.227	23,891.531	56.6	13534.1
04 – INCO, Garson Mine	MW 0100	157	1,173.000	2,282.000	5,883.000	2,630.287	35.9	943.3
05 – Noranda Minerals, Geco Division	PR 0100	142	3,292.000	5,975.000	7,550.000	5,932.669	15.7	928.8
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	1,000.000	14,050.000	51,600.000	16,631.082	62.0	10313.0
07 – INCO, Levack Mine	MW 0100	148	53.000	1,962.500	15,557.000	2,282.365	95.0	2168.3
08 – Falconbridge, Lockerby	MW 0100	157	334.450	1,247.700	4,035.900	1,353.024	37.6	508.6
09 – Falconbridge, Metallurgical	PR 0100	156	4,300.000	39,300.000	309,600.000	50,809.293	72.6	36885.1
10 – INCO, Refinery, Sudbury	SR 0100	157	760.000	3,615.000	8,614.000	3,490.338	34.1	1190.3
11 – INCO, Nolin Creek T.P.	SW 0100	12	2,400.000	16,500.000	28,800.000	16,000.000	47.3	7563.7
12 – Falconbridge, Onaping	MW 0100	157	247.500	1,035.100	4,566.300	1,072.836	46.7	501.2
13 – INCO, Refinery, Port Colborne	SR 0100	154	1,253.000	9,900.000	21,400.000	10,009.946	32.1	3214.3
14 – INCO, Shebandowan Mine	PR 0100	154	883.000	4,713.000	13,865.000	4,793.857	46.5	2228.1
15 – Falconbridge, Strathcona	PR 0100	119	25.246	26,830.000	129,461.102	31,520.809	77.9	24547.6
16 – INCO, Whistle Mine	MW 0100	89	6.000	359.000	3,100.000	527.382	109.2	575.8
17 – Minnova, Winston Lake Mine	PR 0100	99	356.000	1,720.000	4,567.000	1,668.404	45.2	753.7
19 – Dickenson, Arthur W. White Mine	PR 0100	136	964.000	17,160.000	146,512.000	36,154.301	101.4	36652.9
21 – Canamax, Bell Creek Mine	PR 0100	42	47.000	1,091.000	3,000.000	1,329.857	60.3	801.4
24 – Teck – Corona, David Bell Mine	PR 0100	110	385.000	2,640.000	3,360.000	2,540.764	18.7	474.9
25 – Placer Dome, Detour Lake Mine	PR 0100	157	10.000	11,690.000	192,400.000	30,289.299	140.4	42518.1
26 – Placer Dome, Dome Mine	PR 0100	78	3,523.000	14,873.500	65,086.000	19,633.051	71.5	14047.0
27 – Placer Dome, Dona Lake Mine	PR 0100	60	5,204.000	24,373.500	49,272.000	25,626.633	37.1	9498.1
28 – Eastmaque Gold Mines	PR 0100	156	485.000	5,472.500	48,911.000	9,325.487	109.0	10161.7
29 – Giant Yellowknife, ERG Res.	PR 0100	18	28,800.000	47,650.000	115,680.000	64,043.332	62.5	39996.3
30 – Hemlo Gold Mines, Golden Giant	PR 0100	69	456.000	5,743.000	6,292.000	5,289.667	20.9	1104.9
31 – Canamax, Kremzar Mine	PR 0100	47	4,969.000	13,947.000	18,592.000	11,426.276	44.8	5119.7
32 – LAC Minerals, Macassa Division	PR 0100	156	346.000	4,904.000	310,726.000	22,215.385	276.3	61376.1
35 – Canamax, Marhill Mine	MW 0100	156	556.000	1,185.000	1,998.000	1,248.987	20.7	258.2
36 – American Barrick, McDermott	PR 0100	22	18,273.000	30,956.000	35,362.000	29,496.727	16.5	4866.9
37 – Bond Gold, Muskegsagagagen La	PR 0100	136	59.000	900.000	15,276.000	2,082.846	135.7	2826.5
38 – LAC Minerals, Williams Mine	MW 0100	24	31.000	1,710.000	5,600.000	1,577.792	89.7	1414.5
38 – LAC Minerals, Williams Mine	PR 0200	64	5,499.000	13,447.000	14,274.000	13,279.016	10.8	1428.7
39 – Giant Yellowknife, Pamour #1	PR 0100	117	40.000	2,670.000	20,380.000	4,005.299	96 4	3862.8
39 – Giant Yellowknife, Pamour #1	PR 0200	22	90.000	260.000	4,020.000	1,184.545	111.0	1315.0
40 – Giant Yellowknife, P-S	MW 0100	0						
42 – Renabie Gold Mines	PR 0100	84	3.000	3,740.500	101,322.000	9,379.346	198.3	18595.1
45 – St. Andrews Gold Fields	PR 0100	61	432.000	1,209.600	3,456.000	1,343.355	53.8	722.1
46 – Algoma Steel, Ore Division	PR 0100	78	5,189.160	9,535.000	15,474.000	9,621.167	21.0	2023.7
51 – Denison Mines, Denison Property	PR 0100	158	12,787.000	28,771.000	42,163.000	29,309.949	16 4	4798.0
51 – Denison Mines, Denison Property	SW 0200	12	173.000	259.000	950.000	354.917	68.2	241.9
52 – Rio Algom, Lacnor/Nordic	SW 0100	12	129.600	4,372.000	20,045.000	6,715.550	105.9	7111.8
53 – Rio Algom, Panel	SR 0100	145	2,290.000	10,308.000	18,334.000	9,889.959	25.2	2489.8
54 – Rio Algom, Pronto	SW 0100	6	2,678.000	9,374.500	14,800.000	8,989.833	54.7	4914.7
55 – Rio Algom, Ourke	PR 0100	149	345.000	17,159.000	39,442.000	18,470.779	56.4	10415.8
56 – Cameco, Refinery, Blind River	SR 0300	97	153.000	667.000	1,298.000	667.701	22.9	153.2
57 – Cameco, Refinery, Port Hope	SR 0100	100	3,805.000	19,786.500	27,402.000	19,093.311	24.7	4713.9
57 – Cameco, Refinery, Port Hope	SR 0200	102	319.000	1,827.000	3,964.000	1,803.559	40.3	726.4
57 – Cameco, Refinery, Port Hope	SR 0300	103	136.000	694.000	1,087.000	625.311	38.8	242.4
58 – Rio Algom, Stanleigh	SR 0100	145	683.000	20,183.000	28,313.000	18,654.504	33.4	6226.2
59 – Denison Mines, Stanrock	SW 0100	12	92.000	1,516.000	6,599.000	2,442.583	88.4	2159.4

For the purposes of the Metal Mining Effluent Monitoring Regulation, the Metal Mining Sector was divided into the following subsectors:

- copper, lead, zinc, nickel
- gold
- iron
- salt (sodium chloride)
- silver
- uranium

By March, 1992, the salt subsector had been transferred to the Industrial Minerals Sector. No silver mines were operating and only one iron mine was operating. In addition, a public announcement had been made that all remaining uranium mines in the Province would be closing. As a consequence, at the time of writing, the Metal Mining Sector in Ontario consisted largely of copper, lead, zinc, nickel and gold operations.

The annual precipitation in the metal mining regions of Ontario consists of approximately 79 centimetres of rain and 285 centimetres of snow. Summer temperatures in excess of 25 degrees Celsius and winter temperatures below minus 30 degrees Celsius are common. In contrast, it should be noted that most metal mines in the United States are located in arid or "rain shadow" regions.

Even though the industry discharged approximately 153,000,000 gallons of wastewater per day during the monitoring period, this amount of water represents only a small portion of the water that is actually used in the operations. Routinely, over 75 per cent of all water required at an Ontario mine/mill operation is obtained by recycling wastewater.

Natural water that percolates into a mine and the water that is deliberately pumped into a mine for use may come into contact with a variety of substances that can include reactive mineralized rock, mine-machinery lubricants, trace quantities of various explosives and rock fines. If mill water is used to convey tailings underground for use as backfill, the minewater may also carry traces of the various chemicals that are used in the milling of the ore. Minewater must be removed from the mine or the mine would flood.

Large quantities of water are normally used in the milling of Ontario ores. This water can come into contact with a variety of chemicals that are used to process the ore. This water, along with large quantities of finely divided waste rock (tailings), is directed to an impoundment area (tailings area). The solids settle out and remain in the tailings impoundment. Water that is not required for process activities is subjected to further treatment (if necessary) and then released to the environment.

Wastewaters generated by the Metal Mining Sector may be held for long periods of time before release to the environment. Retention times of six months to one year are common at large properties.

PRODUCTION PROCESSES

Production processes commonly used in the Ontario metal mining industry are described in some detail in the Ministry publication entitled "The Development Document For The Draft Effluent Monitoring Regulation For The Ontario Mineral Industry Sector: Group "A" " February, 1989; ISBN 0-7729-5227-2.

INDUSTRY CATEGORIES

For the purposes of the Metal Mining Sector Effluent Monitoring Regulation, the industry was subdivided into six very distinct subsectors as follows:

- copper, lead, zinc, nickel
- gold
- iron
- salt (sodium chloride)
- silver
- uranium

Note: Salt was subsequently transferred into the Industrial Minerals Sector.

On examination of the effluent data received as a result of the required 12 months of monitoring, the Metal Mining Joint Technical Committee came to the conclusion that, while there were differences in effluent quality on a subsector-to-subsector basis, the differences were not substantial. As a consequence, the concept of subsectors was dropped. For the purposes of the Metal Mining Effluent Limits Regulation, all metal mines in Ontario are subject to the same general requirements.

WATER USE AND WASTEWATER TREATMENT

Water is used extensively at Ontario metal mining sites. The industry, however, obtains most of its water by recycling mine-mill effluents. Recycle rates of 75% are common. During 1990, the total volume of wastewater discharged from the industry was approximately 695,000 cubic meters per day (153,000,000 gallons per day).

There are two common sources of wastewater at most Ontario metal mining operations. They are:

- the mine and its associated facilities and
- the tailings disposal area and its associated facilities

The Mine

Natural surface water percolates into most mine workings at rates which are almost impossible to predetermine. Rain and snow fall directly into open pits. In most cases, this natural water comes into intimate contact with any exposed minerals that occur in the orebody or in the associated waste rock. It is somewhat easier to predict the amount of natural water that will gain access to an open pit than it is to predict the amount of natural water that will gain access to underground mine workings. In Northern Ontario, for instance, each hectare of land, in general, receives a daily average of over 20,000 litres of water due to natural precipitation. It is not known what percentage of this water will leave any particular area as runoff or what percentage of this water will evaporate or what percentage will be retained by the land itself. It is obvious, however, that a 20 hectare open pit will receive an average of 20 x 20,000 = 400,000 litres of water per day from natural sources.

In addition to natural water influents, water is pumped underground for mining purposes. In many cases, this aspect of underground water consumption is quite predictable. For instance, water is used underground for drilling, dust suppression, pumping, cooling and sanitation.

The quantity of water used in drilling operations can be predicted with reasonable accuracy on the basis of such things as manufacturers recommendations.

Drilling time can be computed from the diamond drilling experience which normally precedes the exploitation of any orebody. From the exploration drilling and subsequent to the selection of the mining system it should be possible to forecast the drilling hours required for:

- development footage
- stope development footage
- production drilling footage

Water usage for the purposes of dust suppression can be determined on the basis of:

- the number of rounds taken per day .
- the number of transfer points in the ore transportation system
- crushing plant installation and ventilation
- general allowances for hose clean up and geological examinations, and
- ventilation humidity requirements

With regard to pumping, the water requirement relates to gland water and is more or less directly dependent on the number of pumps being used, the size of the various pumps and the operating

pressure of the pumps.

The amount of cooling water used underground for regulating the bearing temperature on equipment such as crushers, fans and compressors can be accurately predicted on the basis of manufacturers specifications.

In many instances, a predictable volume of water may be used in mines where underground sanitary facilities are provided. This volume of water is more or less directly related to the number of employees in any given period.

Where backfill is used in a mine, water (generally mill water) will be used to convey tailings from the mill to the underground workings.

In summary, the natural water that percolates into a mine (open pit or underground) and the water that is deliberately pumped into an open pit or underground mine for process use comes into contact with the mineralized rock. This water must be removed from the mine or the mine would flood. The water is therefore collected in one or more sumps and is pumped to the surface (or out of the pit). This water, while it is resident in the mine, is contaminated by the mining process itself. It may contain quantities of mine-machinery lubricants, trace quantities of various explosives, rock-fines, mine water treatment chemicals and traces of all of the chemical materials that are used in and around a mine. If mill water is used to convey tailings underground for use as backfill, then the minewater can also become contaminated with all of the chemicals that are used in the mill. Since backfill is not used in open pit operations, the overall chemical characteristics of minewater from open pit and from underground operations tend to differ somewhat.

Minewater may be acid due to the decomposition of iron sulphides if they exist in the ore or minewater may be quite alkaline due to the use of cemented backfill. Ontario mine effluents vary considerably with regard to acidity and alkalinity.

The Tailings Disposal Area

In Ontario, any waste mill slurry produced by a mine-mill operation must be directed to an engineered impoundment area called a "tailings area". A common size for these tailings areas in the Province is from 40 to 120 hectares. Formal tailings areas that cover less than 5 hectares do exist in Ontario as do major tailings areas that cover more than 500 hectares. Tailings dams in Ontario are commonly less than 15 meters in height although dams in excess of this height are known in nearly all of the mining camps.

The decant (overflow) from the tailings area is normally the largest and most important single wastewater flow at a mine-mill operation. This wastewater reflects the chemistry of the mill and

quite often the mine and is influenced by practices such as recycling and backfilling. The quality of the wastewater may be influenced by the spontaneous decomposition of mineral species being held in the area itself. The chemistry of a tailings area decant will vary from mine to mine and from mining camp to mining camp. The pH of the untreated effluent , like minewater, may be acid or alkaline. The untreated effluent may contain suspended solids, residual mine-mill chemicals, heavy metals, ammonia, arsenic and, in the case of nuclear properties, may contain radioactive substances. Wastewater from a tailings area is often returned to a mill for re-use. Seepage from the bases of dams will be returned to the tailings area or, more commonly, will be directed to the tailings area treatment system for treatment. In some cases, particularly at properties that mine uncomplicated ores, a simple tailings area may provide all of the treatment that is necessary before the effluent is released to the environment. In most cases, however, additional treatment is required.

Other Sources of Wastewater

Runoff

In some cases, inactive tailings areas associated with active properties are equipped with permanent waste treatment facilities that intercept or collect runoff and subject it to treatment before discharge to the environment. In many cases, this type of runoff is acid and is caused by the spontaneous decomposition of iron sulphides that are normally rejected as a waste at many mining properties. This type of runoff is characterized by a low pH, a high sulphates and total dissolved solids content and the presence of various amounts of metals (and radionuclides at nuclear properties). Runoff may also originate on parking lots, roof drains and loadout areas in the vicinity of mine-mill buildings. Runoff of this nature should be collected and treated. Suspended solids and associated metals are routinely the main problems encountered with this type of waste.

Smelter-Refinery Effluents

Most major smelters and refineries in Ontario discharge their wastes to tailings areas associated with their respective mines and mills. These effluents then become part of the tailings area decants and are treated as such. However, a few plants do discharge their wastes directly to a receiving watercourse. The wastewaters generated by these plants are unique to each plant and are related to the chemistry or metallurgy of the processes being used at each plant.

In the Metal Mining Limits Regulation:

- "PROCESS EFFLUENT" includes minewater, tailings area overflows (decants), smelter-refinery effluents, waste disposal site effluents, cooling water blowdown and contaminated cooling water
- "MINEWATER EFFLUENT" includes effluents from a mine, pit or quarry
- "SMELTER-REFINERY EFFLUENT" includes effluents from a smelter, a refinery or both
- "EMERGENCY OVERFLOW EFFLUENT" includes effluents discharged through an engineered structure that has been designed to protect waste disposal facilities from catastrophic failure, and is not considered to be a "process effluent"

WASTEWATER TREATMENT

In-Plant Controls

In-plant controls are cost-effective methods of limiting the discharge of pollutants through process modifications, chemical substitution and water reduction and recycling.

Process modifications in the metal mining sector have included measures to improve the efficiency of mine-mill operations thereby reducing the amount of pollutants discharged in wastewaters. In addition, chemical storage areas have been contained and spills are directed to retention or waste treatment systems.

Chemical substitution involves the replacement of certain process chemicals (known to be toxic and/or persistent) with chemicals of lower toxicity or greater treatability. This is a standard practice of the metal mining sector. An example is the current use of MIBC (methylisobutylcarbinol) instead of pine oil (a source of alpha terpineol).

In-plant recycling of wastewaters is common. The recycling of tailings area effluents and the re-use of minewater is practiced to the maximum extent allowed by present technical knowledge.

Types of Wastewater Treatment

At most Ontario mining operations, wastewater treatment revolves around pH control and the control of suspended solids. At many operations, this is all that is required. At some operations, the pH is in the proper range and control of suspended solids is all that is required. When ores or wastes are acid-producing, neutralization is carried out. Neutralization using lime is common

although other bases can and have been used.

Since most tailings areas have calculated retention times in the order of months or years and since tailings area overflows are commonly baffled to prevent the escape of floating materials such as oils, some milling chemicals and general debris, tailings areas by themselves can have a significant impact on containing and degrading wastes. Processes such as photo-decomposition, aeration, sedimentation and bio-chemical degradation are all active in a properly designed tailings area. Where a tailings area alone cannot accomplish required waste treatment, the decant is directed to downstream polishing ponds where additional treatment is carried out. Many tailings area effluent volumes are reduced substantially (over 75%) by the practice of wastewater recycle.

Special treatment problems can and do arise in the metal mining sector. Gold mines, for example, generally use substantial quantities of cyanide to win gold from ore. As a result, cyanide treatment is required at most gold mines. When cyanide complexes are simple, ponding of wastes in contact with the atmosphere may be all that is required. However, in many cases, treatment of cyanide using substances such as hydrogen peroxide or sulphur dioxide is required and is carried out. Acid mine drainage is a problem at some Ontario mining properties and many neutralization plants have been put in place to achieve neutral metal-free effluents. Some of these acid flows are radioactive and control of the radionuclides is carried out. Barium chloride, for example, is added to control radium in effluents.

Minewater can be handled in at least one of the following ways:

- the minewater can be directed to the mill for re-use, or
- the minewater can be directed to the tailings area, or
- the minewater can be collected and treated by itself

All three methods of handling minewater have advantages and disadvantages. All three methods are presently in use in Ontario.

In Ontario, minewater is collected and treated by itself if:

- the mine is located a considerable distance from the mill, or
- the chemistry of the minewater is such that the minewater cannot be used as make-up water in the mill circuit, or
- the mill is operating in closed circuit with its tailings area in order to accomplish a specific objective

In Ontario, minewater is directed to a tailings area when:

- a mine is close to its corresponding tailings area, or
- the minewater is not acceptable for direct use in the mill circuit, or
- separate treatment of the minewater would force a duplication of the tailings area decant treatment facilities

In Ontario, minewater is directed to the mill whenever and wherever possible.

In Ontario, the first step in the control of seepage from tailings areas is to collect the seepage. After collection, the seepage can be handled in one (or more) of three ways:

- the seepage can be treated by itself, or
- the seepage can be pumped back into the tailings area, or
- the seepage can be directed to the treatment facility that treats the tailings area decant

Depending on local circumstances, all three methods of seepage control are being used in Ontario.

Seepage can contain substances that can aggravate existing waste treatment problems. For example, care must be taken when seepage is returned to a tailings area. Ferric iron contained in the seepage could aggravate an existing acid mine drainage problem.

Many metals found in metal mining effluents are present in these effluents in particulate form; that is, the metals are present as finely divided ore or waste particles. Careful suspended solids control at most plants will generally result in satisfactory control of metals in effluents. Where metals actually occur in a dissolved form, careful neutralization and settling will resolve most problems. However, some compounds found in the metal mining sector do not respond well to these strategies. Chief among these is ammonia which is a common constituent of most minewaters and is frequently detected in decants from tailings areas. Chemical substitution has been carried out in cases where ammonia itself has been used as a chemical in a mine or in a mill. However, ammonia in minewater has, as its primary source, the explosives used to break rock. Aside from good housekeeping practices, economical treatment strategies for ammonia control in the metal mining sector are not presently available.

METAL MINING SECTOR
CURRENT TOTAL ANNUAL LOADINGS (KG/YEAR)

Organics

toluene	40.7
meta and para cresol	25.0
ortho, meta and para xylene	22.7
carbon tetrachloride	12.5
methylene chloride	10.8
benzene	10.3
2-methylnaphthalene	8.4
naphthalene	6.5
chloroform	6.4

Metals

iron	100,000
nickel	59,000
zinc	40,900
copper	37,700
aluminum	33,100
molybdenum	6,370
cobalt	5,260
uranium	3,530
antimony	1,770
lead	1,470
cadmium	723
mercury	540
chromium	20

Others

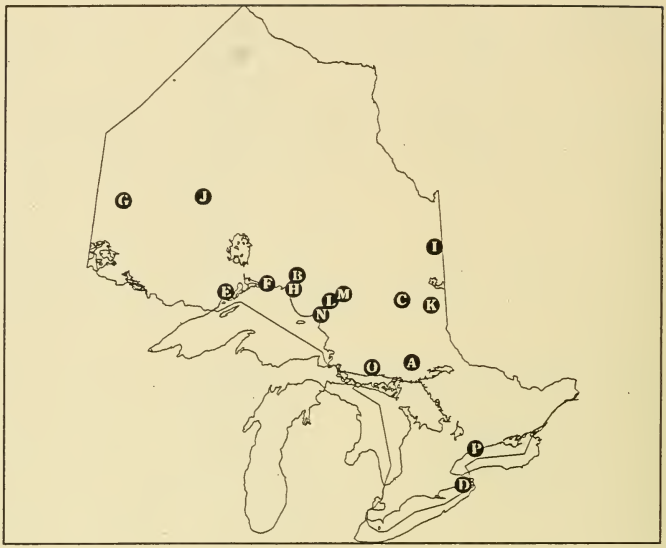
total cyanide	44,800
cyanide (weak acid dissociable)	13,300
cyanates (filtered)	34,800
thiocyanates (filtered)	848,000
ammonia plus ammonium	1,580,000
nitrate plus nitrite	1,930,000
suspended solids	2,110,000
dissolved solids	293,000,000
sulphates	153,000,000
chlorides	16,500,000
phenolics (4AAP)	1,840
arsenic	12,500
selenium	9,590
phosphorus	3,280
chemical oxygen demand	6,400,000

CURRENT TOXICITY OF ONTARIO METAL MINING SECTOR EFFLUENTS

- 54% of all effluents toxic to rainbow trout
- 48% of all effluents toxic to daphnia magna

The following map indicates the general location of all plants in the sector that were monitored during the MISA monitoring period (February 1, 1990 to January 31, 1991):

LOCATION OF MINES



KEY

MAP REF.	LOCATION	PLANT	ITEM No.
A	SUDBURY*	COPPER CLIFF TREATMENT PLANT	01
A	SUDBURY	CREAN HILL MINE	02
A	SUDBURY	FALCONBRIDGE OPERATION SITE	03
A	SUDBURY	GARSON MINE	04
A	SUDBURY	LEVACK MINE	07
A	SUDBURY	LOCKERBY MINE	08
A	SUDBURY	NICKEL REFINERY	10
A	SUDBURY	NOLIN CREEK TREATMENT PLANT	11
A	SUDBURY	ONAPING MINE	12
A	SUDBURY	STRATHCONA MINE	15
A	SUDBURY	WHISTLE MINE	16
B	MANITOUWADGE	GECO MINE	05
C	TIMMINS	KIDD CREEK MINE	06
C	TIMMINS	KID METALURGICAL SITE	09
C	TIMMINS	BELL CREEK MINE	21
C	TIMMINS	DOME MINE	26
C	TIMMINS	ERG RESOURCES	29
C	TIMMINS	MARHILL MINE	35
C	TIMMINS	McDERMOTT MINE	36
C	TIMMINS	PARMOUR #1 MINE	39
C	TIMMINS	ST. ANDREWS GOLDFIELDS	45
D	PORT COLBOURNE	INCO REFINERY	13
E	THUNDER BAY	SHEBANDOWAN MINE	14
F	SCHREIBER	WINSTON LAKE MINE	17
G	RED LAKE	ARTHUR W. WHITE MINE	19
G	RED LAKE	CAMPBELL RED LAKE MINE	23
H	HEMLO	DAVID BELL MINE	24
H	HEMLO	GOLDEN GIANT MINE	30
H	HEMLO	WILLIAMS MINE	38
I	DETOUR LAKE	DETOUR LAKE MINE	25
J	PICKLE LAKE	DONA LAKE MINE	27
J	PICKLE LAKE	MUSKEGSAGAGEN LAKE MINE	37
K	KIRKLAND LAKE	EASTMAQUE GOLD MINE	28
K	KIRKLAND LAKE	MACASSA DIVISION	32
L	FINAN TOWNSHIP	KREMZAR MINE	31
L	FINAN TOWNSHIP	MAGNACON MINE	33
M	RENABIE	RENABIE GOLD MINE	42
N	WAWA	ALGOMA ORE DIVISION	46
O	ELLIOT LAKE**	DENISON MINES	51
O	ELLIOT LAKE	LAGNOR/NORDIC MINE	52
O	ELLIOT LAKE	PANEL MINE	53
O	ELLIOT LAKE	PRONTO MINE	54
O	ELLIOT LAKE	QUIRKE MINE	55
O	ELLIOT LAKE	STANLEIGH MINE	58
O	ELLIOT LAKE	STANROCK MINE	59
O	ELLIOT LAKE	CAMECO NUCLEAR REFINERY	56
P	PORT HOPE	CAMECO NUCLEAR REFINERY	57

* SUDBURY/FALCONBRIDGE

** ELLIOT LAKE/BLIND RIVER

Waste Characterization Information Database

Chapter Three

of the

Development Document

WASTE CHARACTERIZATION INFORMATION DATABASE

This chapter presents information about the sources of data used in developing the metal mining effluent limits regulation. The chapter includes some discussion about the reliability of the data and the sources.

Waste characterization efforts are described in two parts:

- pre-regulation monitoring
- MISA monitoring

PRE-REGULATION MONITORING

In 1987, under the voluntary MISA pre-regulation monitoring program, ZENON Environmental Inc. undertook a project on behalf of the Ontario Mining Association (OMA) to characterize effluent streams from (10) representative mining and milling operations in Ontario.

The first round of sampling took place in July, 1987. The second round of sampling took place in September, 1987. The sampling and analytical procedures were approved by the Ministry of the Environment prior to the commencement of the program.

The scope of analytical work carried out in the two sampling campaigns included a list of conventional pollutants, the MOE EMPPL as published at the time of sample collection, an open organic scan and an elemental scan. Sample collection and analysis were performed according to widely accepted standard protocols employing strict quality assurance/quality control procedures.

The results of the pre-regulation monitoring exercise are documented in a report entitled "MISA Pre-Regulation Monitoring Program: Prepared for the Ontario Mining Association by ZENON Environmental Inc.; April 18, 1988".

The mining operations sampled during the pre-regulation monitoring program were selected on the basis of the metals/minerals being processed and the processing methods being employed at the properties. The properties chosen were thought to be representative of the industry in general. All five of the major base metal producers were sampled; two of the fifteen gold producers were sampled (one carbon-in-pulp; one Merrill-Crowe); one of the four uranium producers was sampled; one (taconite) of the three iron producers was sampled and one of the two salt producers was sampled (salt was later transferred to the Industrial Minerals Sector).

In general, because of the long waste retention times available at most properties, single grab samples were taken. However, 12-hour composite samples were taken at a large base metal property due to the short retention time available at the site and a

composite of three waste streams proportioned on the basis of flow was taken at a salt property. In almost all cases, staff of the Ministry of the Environment were present when samples were taken and in almost all cases, duplicate samples were taken by the Ministry of the Environment.

Of the available intercomparison data (MOE/ZENON), agreement was generally within the limits normally achievable by reputable laboratories following similar analytical methods.

Results: Conventional Parameters; Elemental Scans

Routine (expected) levels of normally found analytes were detected. It has been a practice within the metal mining sector to run elemental scans on effluents on at least a yearly basis since the early 1970's. The pre-regulation data contained no surprises.

Results: Organics

Most data were below detection limits. The audit data was essentially in complete agreement, allowing for the odd random "hit" that invariably occurs when a large number of samples are analyzed for a wide range of parameters.

The GC/MS open characterization analysis revealed a number of classes of organic compounds that were primarily polypropylene glycols, carboxylic acids, turpenoids, turpenes and hydrocarbons. These were found in base metal effluents associated with (froth) flotation circuits. The compounds, detected in very low concentrations, were directly related to known mining chemicals such as pine oil (use now largely discontinued as a result of this program) and kerosene.

In addition to the above, the following EMPPL organics were detected:

• dibromochloromethane (RMDL=1.1 ppb)	(in sample blanks only)	3 ppb
• chloroform (RMDL=0.7 ppb)	(in sample blanks)	2 to 3 ppb
	(in minewater:one site)	6 ppb
• trichloroethylene (RMDL=1.9 ppb)	(in minewater:one site)	5 ppb
	(in process effluents: two sites)	2 to 8 ppb
• trichlorofluoromethane (RMDL=1 ppb)	(in process effluent: one site)	2 ppb
• methylene chloride (RMDL=1.3 ppb)	(in sample blanks)	3 to 16 ppb
	(in minewater and process effluents: four sites)	2 to 16 ppb

• benzene (RMDL=0.5 ppb)	(in sample blanks)	3 ppb
	(in minewater and process effluents: one site)	2 to 8 ppb
• ethylbenzene (RMDL=0.6 ppb)	(in process effluents: one site)	3ppb
• toluene (RMDL=0.5 ppb)	(in sample blanks)	1 to 2 ppb
	(in minewater and process effluents: two sites)	1 to 2 ppb
• aniline (RMDL=)	(in process effluent: one site)	230 ppb
• o-xylene (RMDL=0.5 ppb)	(in process effluent: one site)	5 to 12 ppb
• m and p-xylene (RMDL=1.1 ppb)	(in process effluents: two sites)	2 to 8 ppb
• 1-methylnapthalene (RMDL=3.2 ppb)	(in process effluents: one site)	3 ppb
• 2-methylnapthalene (RMDL=2.2 ppb)	(in process effluents: one site)	15 ppb
• napthalene (RMDL=1.6 ppb)	(in process effluents: one site)	11 ppb
• phenanthrene (RMDL=0.4 ppb)	(in process effluents: one site)	2 ppb
• o-cresol (RMDL=3.7 ppb)	(in process effluents: one site)	15 to 17 ppb
• p-cresol (RMDL=3.5 ppb)	(in process effluents: one site)	38 to 40 ppb

No positives were observed for any of the PCDD/PCDF samples in the second round of sampling. A trace level of OCDD below the Ministry required detection limit (at the time 0.3 ng/litre) was observed in one sample during round one at one gold mine.

PCB's were not detected.

Note: In subsequent months, an effort was made to determine the cause or source of the aniline noted above. Aniline was not detected at the property in the intense round of MISA sampling that followed. In addition, no source of aniline could be found at the property. The pre-regulation round of monitoring also clearly indicated that many samples were being contaminated with organics by laboratory procedures. Many of the blank samples contained organics.

MISA MONITORING

MISA monitoring data for the metal mining sector were collected under Ontario Regulation 491/89 as amended to Ontario Regulation 44/90. Monitoring under this regulation began on February 1, 1990 and concluded on January 31, 1991.

During the MISA monitoring period, data were collected by industry according to Ministry specifications described in the above regulations. The companies were also required to conduct a quality control program to help validate the monitoring data. Besides flow monitoring and sampling for chemical analyses, the dischargers were required to do toxicity testing on their effluents using rainbow trout and Daphnia magna. Industry, in general, contracted commercial laboratories for the trace contaminant analyses and toxicity testing.

Each company reported its monitoring data to the Regional Ministry Office involved in electronic form, using the MISA DATA Entry System (MIDES). Regional staff of the Ministry checked the data for completeness and transmitted the data to the Ministry's central Sample Information System.

The Ministry regional staff closely observed compliance by the companies with the monitoring regulation. They inspected the plants during the monitoring period and conducted audit sampling. The Ministry's laboratory performed audit sample analyses to verify the analytical data collected by the industry. The Ministry also performed open scan characterizations on the effluents to assist in the identification of the chemical nature of sector effluents.

The final results of the MISA monitoring program for the metal mining sector have been published in report form. The title of the report is "Status Report: The Metal Mining Sector Effluent Monitoring Data: For The Period February 1, 1990 to January 31, 1991" (700 pages)(ISBN 0-7778-0317-8). In addition, the toxicity data generated by the MISA monitoring program has been published in a separate document entitled "Acute Lethality Data For Ontario's Metal Mining Sector Effluents Covering The Period From February 1990 to January 1991" (97 pages)(ISBN 0-7729-9766-7).

The total quantity of data collected during the 12-month monitoring period was as follows:

Type of Effluent	Number of Data Points
smelter/refinery effluent	12,065
minewater effluent	18,367
process (tailings area) effluent	45,221
storm water (runoff) effluent	3,679
quality control	95,949
Ministry audit	8,292
Total	183,573

The large amount of quality control data shown above was necessary in the metal mining sector. Much of the sampling was done in remote areas in difficult weather conditions. Sampling conditions were sometimes dangerous and sample transport a challenge.

The cost to industry of the data collection under the MISA Metal Mining Effluent Monitoring Regulation was estimated to be in the range of 13 to 18 million dollars (Canadian).

The majority of the samples taken under the effluent monitoring regulation were composite samples that consisted of 3 grab samples taken within an 8-hour period and then combined to form a composite sample. A large number of grab samples were also taken depending on the retention time of the wastes involved. A few samples taken were composite samples based on continuous sampling.

The frequency of sampling under the Metal Mining Sector Effluent Monitoring Regulation varied depending on factors such as the individual characteristics of the subsector or property involved. In general, however, sampling was carried out on a "three times per week", "monthly" and "quarterly" basis. Parameters that were placed in these categories, on a subsector or site-by-site basis, are as follows:

Three Times Per Week

pH, suspended solids, oil and grease, ammonia plus ammonium, total cyanide, weak acid dissociable cyanide, arsenic, copper, nickel, lead, zinc and iron

Monthly

chemical oxygen demand, total kjeldahl nitrogen, nitrate plus nitrite, ammonia plus ammonium, dissolved solids, phenolics (4AAP), sulphates, cyanates, thiocyanates, phosphorus, arsenic, cadmium, cobalt, mercury, iron, chromium, copper, lead, zinc, vanadium and uranium

Quarterly

a standard list (the sector list) of 150 parameters
toxicity (rainbow trout and Daphnia magna)

During the monitoring period, each direct discharger was required to measure or estimate the flow of each effluent stream at the time of sampling and at a location or set of locations representative of the flow at the sampling point. Methods, devices or calculations for the measurement or estimation of flow had to be capable of accuracy to within plus or minus 20 % of the actual flow. In addition, the Ministry of the Environment conducted audits of the methods, devices or calculations for the measurement or estimation of flow at selected properties.

Quality assurance and quality control (QA/QC) include all of the procedures undertaken to ensure that data produced are within known probability limits of accuracy and precision. QA/QC was one of the most important aspects of the Metal Mining Sector monitoring program. 50 % of all data points generated were QA/QC data points. The QA/QC program included many small but essential activities ranging from proving the cleanliness of sample bottles; using proper sampling equipment, containers and preservatives; instrument calibration; validation of authenticity of standards; inclusion of blanks, spikes and controls in analytical runs; documenting performance; and, defining a method for reporting a final data number.

The Metal Mining Sector database is considered to accurately represent the general nature of effluents discharged by active properties within the sector for the period February 1, 1990 to January 31, 1991. In the intervening period of time, several properties have closed and a few new mines are operating. Such is the nature of the sector.

Sampling took place at all major plants in the sector with the exception of a very small number of plants that were in the process of termination of activities. Plants within the sample group accounted for more than 95 % of mine production within the sector. Sampling was not carried out at properties that generated an effluent flow of less than 50 cubic meters (approximately 11,000 gallons) per day.

Plants monitored within the sector, in general, did not operate on a continuous basis throughout the monitoring period. In addition, many operating plants held wastes for varying lengths of time in order to make use of a waste treatment process termed "natural degradation". This has been a common practice within the industry for a number of years. In general, there is no effluent discharge while wastes are being held.

The document referred to previously entitled "Status Report: The Metal Mining Sector Effluent Monitoring Data" includes the following:

- a complete description of the metal mining monitoring program
- a listing of all monitoring and audit data
- the total number of days of effluent discharge at all properties sampled
- a complete quality assurance/quality control report
- a summary of all flow data for each property sampled
- complete documentation of all long term average concentrations and loadings for each property sampled
- monthly average concentration plots for 16 major parameters for all waste streams sampled
- daily concentration plots for 8 major parameters for all waste streams sampled
- complete loading tables on a sector and subsector basis
- a complete list of all dioxin and PCB monitoring data
- a summary of a Ministry report (referred to above) concerning the toxicity of Ontario metal mining effluents
- a complete summary of existing Ontario Provincial Water Quality Objectives and Guidelines

Data Quality

Data quality concerns include the possibility that:
- low results represent false positive findings
- non-detected results represent false negative findings
- results are underestimated or overestimated
- analytes are misidentified

The quality of the data compiled is determined through an evaluation of the remark codes that may be associated with individual test results and by the QC data collected. Based on this assessment (which is outlined in detail in the document entitled "Status Report: The Metal Mining Sector Effluent Monitoring Data"), parameters may be excluded from further consideration in limit setting.

The following table entitled " Number of Streams Selected by Parameter With Acceptable Data Quality" provides the final list of parameters that were selected (after QA/QC procedures) for further consideration in the limit setting process.

Number of Streams Selected by Parameter
With Acceptable Data Quality
MISA METAL MINING SECTOR
12 – Month Monitoring Data
February 1, 1990 to January 31, 1991

ATG	PARAMETER	NUMBER OF STREAMS SELECTED
01	COD	43
02	Cyanide Total	27
06	Total phosphorus	12
08	Total suspended solids	40
09	Aluminum	35
	Cadmium	6
	Chromium	1
	Cobalt	19
	Copper	39
	Lead	10
	Molybdenum	7
	Nickel	34
	Zinc	38
10	Antimony	4
	Arsenic	13
	Selenium	5
12	Mercury	7
14	Phenolics (4AAP)	25
	Carbon tetrachloride	1
	Chloroform	2
	Methylene chloride	1
17	Benzene	2
	Toluene	2
	m–Xylene and p–Xylene	1
	o–Xylene	1
19	2–Methylnaphthalene	1
	Naphthalene	1
20	m–Cresol	1
	p–Cresol	1
25	Oil and grease	34
4a	Ammonia plus Ammonium	50
	Total Kjeldahl Nitrogen	48
4b	Nitrate+Nitrite	45
5b	TOC, Total Organic Carbon	17
M1	Chlorides	40
M2	Cyanates, Filtered	2
M3	Dissolved Solids	50
M4	Sulphates	43
M5	Iron	50
M6	Thiocyanates, Filtered	3
M7	Uranium	11
M8	Cyanide (WAD)	16

The Best Available Technology Economically Achievable

Chapter Four

of the

Development Document

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BATEA)

In June of 1986, the Ontario Ministry of the Environment (MOE) introduced the Municipal Industrial Strategy for Abatement (MISA) program to achieve the ultimate goal of the virtual elimination of toxic contaminants in municipal and industrial discharges into Ontario's waterways. This goal was, in part, to be achieved by increasing the emphasis on control technology through the development of effluent limits based on the use of BATEA.

The BAT Subcommittee

A best available technology (BAT) subcommittee was formed under the auspices of the MISA Metal Mining Sector Joint Technical Committee to recommend to the JTC several BAT options that could be used to determine the best available technology economically achievable. The BAT subcommittee consisted of representatives of the Ministry of the Environment, the Ministry of Northern Development and Mines, the Atomic Energy Control Board, Environment Canada and industry.

The BAT Consultant

An important task of the BAT subcommittee was to select a consultant to conduct a study of effluent treatment technologies used by the metal mining industry on a world-wide basis. The subcommittee prepared terms of reference for the project and held an information meeting for potential bidders. The contract was eventually awarded to a consortium of Kilborn Inc. (Kilborn) and The Environmental Applications Group Limited (EAG).

EAG was established in Toronto, Ontario in 1977 by senior professionals in Atmospheric Sciences, Terrestrial Ecology, Socio-Economic and Aquatic studies. EAG has carried out 900 consulting assignments in these and other disciplines in Canada, the United States and abroad. In the fall of 1990, EAG became affiliated with Hardy BBT Ltd., within the AGRA Consulting Engineering Group, which has a combined staff of over 900 engineers, biological and physical scientists, chemists and support personnel.

Kilborn is one of the most respected mining engineering firms in the world. Originally incorporated in 1947, the Kilborn group of companies provide project management, process design, engineering, procurement and construction management services on a world-wide basis. Current total staff is in excess of 1,100 people. Typical mining and metallurgical projects that have been carried out by Kilborn are as follows:

- asbestos: 5 plants, 5 expansions, over 30 studies
- base metals: 25 plants, 26 expansions, over 100 studies
- coal: 4 preparation plants, 3 expansions, 13 handling

facilities, over 40 studies

- ferro-chrome, iron, titanium: 6 plants, 10 studies
- gold and silver: 34 plants, 21 expansions, over 130 studies
- industrial minerals: 25 plants, 60 studies
- potash, potassium salts: 6 plants, 12 expansions, over 30 studies
- uranium: 12 plants, 13 expansions, over 30 studies
- other minerals and rare earths: 12 plants, 20 studies
- autogenous grinding: 21 plants, over 20 studies
- mine headframes, hoists, shafts: over 50 installations
- mine ventilation systems: over 20 projects
- tailings systems: over 50 projects
- underground mines and open pits: over 30 development projects

The BAT Study

The objectives of the BAT study were threefold:

(1) to provide information on existing or alternate industrial processes, effluent treatment works and processes, chemical substitutions and employment of water reduction or re-use;

(2) to provide relevant information on design specifications, as-found treatment performance, operating conditions, effluent quality remediation and capital and operating costs of the technologies;

(3) to recommend, where possible, five options for BAT for each sector plant or group of plants.

In addition, consideration was to be given to technologies that:

- were non-lethal to fish and Daphnia magna
- made maximum use of reduction, re-use and recycling
- did not transfer contaminants to another media
- promoted maximum water conservation
- that made progress towards the elimination of contaminants

As defined by the terms of reference, the study of applicable technologies was to focus on those areas of the world which

contained mining or processing operations for ores or minerals that are similar to those mined in Ontario and where advanced technologies were likely to be used. In addition, where treatment technologies were determined to be climate dependent, emphasis was to be placed on operations which experience similar climatic conditions to those found in Ontario.

The process employed in the selection of BAT options (within the context of the study) was to consider the ability of a given demonstrated technology to remove contaminants in a cost effective and reliable manner.

For each subsector and contaminant of concern, the study was to identify five BAT options (where possible) to satisfy the following criteria:

- the BAT that utilized the best technologies currently in use in North America, Europe, the former Soviet Union, Japan and other countries that are applicable to Ontario mining plants
- a BAT option selected by the U.S. EPA for similar plants
- a technology train that utilized the best technologies currently in use in Ontario in the metal mining sector
- at least one technology that produced an effluent that was non-lethal to rainbow trout and/or Daphnia magna
- at least one technology train consisting of any technology or combination of technologies which potentially advance Ontario metal mining sector plants towards the MISA goal of virtual elimination of persistent toxic contaminants

As a result of the consultant BAT study, a database was to be developed which summarizes technical design, operating, performance and cost information for in-plant and effluent control technologies. Best Management Practices (BMP) including spill prevention and control, to minimize discharges of persistent toxic pollutants were also to be addressed.

The consultant BAT report was completed in December of 1991. The report was delivered on time and within budget. The report was accepted by the metal mining JTC and became one of the main working documents of the JTC and the associated JTC working groups. The formal title of the report is "Ontario Ministry of the Environment: Metal Mining Sector: Best Available Pollution Control Technology: December 1991: Second Edition June 1992: Prepared by Kilborn Inc. and The Environmental Applications Group" (290 pages).

In the report itself:

- Sections 1 and 2 focus on study objectives, background, approach and data acquisition

- Section 3 provides a brief description of generic technologies that are potentially available for wastewater treatment in the mining industry. Some of the methods described are already in common use within the industry. At the other end of the spectrum are technologies which are still in development stages (bench scale/pilot plant) and technologies which are used in industries other than mining. The technologies that are described in Section 3 are frequently combined, in various sequences, to produce technology trains. In metal mining, BAT options are most often technology trains as opposed to single technologies.

- Section 4 provides a comparison of effluent quality standards that are applied to the metal mining industry in various regions of the world. Differences in regulatory approaches between Canada, the United States and Europe are also discussed.

- Sections 5 and 6 focus on data acquisition and contact procedures used to develop an inventory of selected plant operations. Recommended/Preferred BAT options are selected on the basis of data provided in the inventory.

- Section 7 is the focal point of the report. Preferred BAT options and technology trains are selected and described. Costs are assigned to each option. In Section 7, generic technology trains are developed (as opposed to providing descriptions of "best plants" in existence). This approach, in metal mining, is more meaningful for purposes of general costing and comparisons. For each BAT train, capital and operating costs are estimated for two levels of effluent flow. Effluent flows are not necessarily related to mine or plant production levels. General assumptions are made regarding the size, configuration and operation of tailings systems to allow cost comparisons.

- Sections 8 and 9 discuss alternative industrial processes and best management practices which can be used to further improve effluent quality, reduce the probability of upsets and reduce discharge volumes. The range, at the present time, of alternative industrial processes is quite limited.

OVERVIEW OF POTENTIAL EFFLUENT CONTROL TECHNOLOGIES

The available technologies were categorized by the consultant according to the type of contaminant removed and were rated according to their utilization in the mining industry as follows:

• widely used	a commonly used method of treatment
• limited use	occasionally used method of treatment
• unique	employed at one or two related sites
• pilot	demonstrated site performance at less than full commercial scale
• potential	a method that could be used but is not due to economics, performance, limited development or present use confined to

other industries

Cyanide Removal

Widely Used	--natural degradation --Inco sulphur dioxide/air --hydrogen peroxide
Limited Use	--alkaline chlorination --acidification/volatilization/regeneration (AVR) --engineered wetlands --Hemlo Gold process
Unique Use	--Homestake bio-degradation process
Pilot Use	--Vitrokele --MNR Degussa process --ion exchange (in combination with AVR)
Potential Use	--electrolytic decomposition --ozonation --activated carbon --Noranda sulphur dioxide process --Kastone peroxide process --CELEC process --ferrous sulphide adsorption

In many cases, the above technologies also bring about the concurrent and/or sequential removal of heavy metals.

Heavy Metal Removal

The wastewater treatment processes outlined here, for heavy metal removal, are viewed primarily from the perspective of treating solutions and/or slurries which do not contain significant concentrations of cyanide. Where such concentrations are present (greater than 1 to 3 mg/litre), reference should be made to "cyanide removal" above.

Widely Used	--tailings ponds --settling ponds --hydroxide precipitation (lime, sodium or potassium hydroxide)
Limited Use	--mechanical settling --coagulants/flocculants in combination with precipitating agents --sulphide precipitation --mechanical filtration --passive filtration (including exfiltration) --engineered wetlands --ion-exchange

Potential Use
--carbonate precipitation
--reverse osmosis
--electrodialysis
--ultra-filtration
--activated carbon adsorption
--electrowinning
--cementation
--silicate precipitation
--Bio-fix process

In many cases, heavy metals in metal mining effluents are present in particulate form. Settling or filtration technologies are required. When metals are in solution, pH adjustment and/or chemical addition may be required in combination with settling/filtration technologies.

Arsenic Removal

Arsenic, which may be present as soluble or colloidal anions in wastewater, requires a separate evaluation because the chemical behaviour of arsenic is considerably different than that displayed by most metals.

Widely Used
--ferric chloride precipitation
--ferric sulphate precipitation
--hydroxide precipitation
--coagulant/flocculant addition

Potential Use
--reverse osmosis
--ion exchange

Suspended Solids Removal

Widely Used
--tailings ponds
--settling ponds
--sumps
--coagulants/flocculants
--mechanical settling

Limited Use
--mechanical filtration (of slurries and sludges)
--mechanical filtration (of dilute suspensions)
--passive filtration
--engineered wetlands

Ammonia Removal

Widely Used	--natural degradation
Unique Use	--Homestake method
Potential Use	--air stripping --steam stripping --biological nitrification/denitrification --break-point chlorination --ion-exchange --electrodialysis --reverse osmosis --alternate use of explosives

Nitrate/Nitrite Removal

Limited Use	--wetland filtration
Potential Use	--denitrification --ion-exchange --electrodialysis --reverse osmosis

Volatile Organics Removal

Widely Used	--tailings ponds
Potential Use	--air stripping --steam stripping

Volatile organics are organic compounds with sufficient vapour pressure to allow their release to the atmosphere. In the mineral processing industry this would include petroleum-based and alcohol-based cleaning products and flotation chemicals (compounds such as varsol, kerosene and MIBC) as well as some of the breakdown products of these compounds. Volatile organics in final effluents were detected at very few sites within the metal mining sector during the MISA program.

Phenolics Removal

Widely Used	--passive aeration
Limited Use	--wetland filtration
Potential Use	--chemical oxidation --biological oxidation --carbon adsorption

Phenolic components can occur in tailings ponds as a result of their use as frothing agents (e.g. cresylic acid). They can also

occur as a result of the breakdown of pine oil which is occasionally used as a frother in mineral flotation. Some collectors used in flotation also contain phenolic groups. The phenolic content in tailings wastewater can therefore be potentially reduced by selecting other reagents if this is practical and economic. Evaluation on a site-specific basis is required. Natural sources of phenolic compounds, resulting from the oxidation of decaying vegetation, especially the bark of certain tree species such as aspen/poplars, can also contribute to the presence of phenolics. Beaver ponds typically show elevated levels of phenolics.

Dissolved Solids

Potential Use	--chemical precipitation --ion-exchange --vapour compression evaporation --vacuum freeze concentration --reverse osmosis --electrodialysis --membrane distillation

Sulphates, carbonates and chlorides are the most prevalent dissolved solids likely to be encountered in metal mining effluents. Sulphates, in particular, can be present in very high concentrations.

pH Control

Widely Used	--lime --limestone --sodium or potassium hydroxide
Limited Use	--sulphuric acid --carbon dioxide --magnesium hydroxide --sodium carbonate

Oil and Grease Control

Widely Used	--gravity separation
Limited Use	--air flotation
Potential Use	--activated carbon adsorption

Toxicity Control

Water treatment processes within the international mining community have generally been directed at the control of specific

contaminants or groups of contaminants and not at toxicity per se. In addition, where toxicity work has been carried out within the international mining community, test species have generally differed from those used in Ontario. As a consequence, correlation of results has not been possible. The primary unknown in addressing toxicity in mining effluents is the identification of the cause of the toxicity. Typically, toxicity results from individual contaminant toxicity as well as from the syergistic toxic effects of several contaminants. Also, even with individual contaminants such as copper it is difficult to link toxicity directly to concentration because of the various ionic and solid phase species potentially present. Other site factors such as pH, temperature, hardness and complexing agents (naturally occurring humic and fulvic acids) also influence the toxicity of the effluent.

Information on the ability of the wastewater treatment technologies, investigated for use in the Ontario metal mining industry, to pass MOE toxicity criteria for trout and daphnia was not available to the consultant while the technology report was being prepared.

Since most, if not all, of the technologies investigated by the consultant were designed to remove contaminants from wastewaters, in most cases of technology application, toxicity of effluents should be reduced. However, the fact remains that removal of one or more of the contaminants in a wastewater could could increase the toxicity of other components of the wastewater.

Zero Volume Discharge

The United States Environmental Proctection Agency (US EPA) defines zero discharge as "zero volume discharge". This concept differs from the objective of the MISA program which is the "virtual elimination of persistent toxic pollutants". Virtual elimination can be attained through either "zero volume discharge" (no discharge of water) or through "zero concentration" of pollutants.

Zero volume discharge is practiced by a large number of U.S. metal mining companies. This is possible because most U.S. metal mining companies are located in arid or "rain shadow" areas". In these areas, annual evaporation exceeds annual precipitation. In Ontario, zero volume discharge is not feasible even with very high rates of recycle. Ontario experiences a net surplus of precipitation over evaporation of from 200 to 500 mm annually.

Actual attainment of "virtual elimination" through the reduction of contaminant concentration is not feasible with known BATEA for the Ontario metal mining sector. Zero volume discharge is attainable using technologies that totally evaporate effluents. The costs of this approach to the Ontario metal mining industry have been estimated to be in excess of 1 billion dollars.

APPROACH TO THE SELECTION OF BEST AVAILABLE TECHNOLOGIES

In reviewing potential BAT level technology trains (combinations of technologies that achieve a goal or goals) applicable to the Ontario Metal Mining Sector, the consultant and JTC refrained from defining single "best" technologies for each subsector. Rather, with qualification, several technology trains were defined which were capable of achieving wastewater effluent control standards equivalent to, or better than, those provided for the US EPA BAT/NSPS standards. This approach is in keeping with findings presented in the 1982 US Development Document for Effluent Limitation Guidelines and Standards for the Ore Mining and Dressing Point Source Category adopted in the US Code of Federal Regulations No. 40, Part 440- Ore Mining And Dressing Point Sources Category (1989).

Inclusion of alternative BAT level technologies allows operators the flexibility to address varying site conditions which typify the Ontario metal mining industry. Most notable, in this regard, are varying geological conditions, topographical limitations affecting possible methods of tailings disposal, specifics of metal recovery process details and site specific environmental sensitivities.

BAT level technology trains identified in the consultant's report were defined for the gold and base metal subsectors only. For iron ore processing operations, suspended solids, pH and total iron levels tend to be of primary concern. These parameters are controlled by primary/secondary settling with the occasional use of flocculating agents. Technologies identified for the base metal and gold subsectors are applicable, on a site specific basis, to most other metal mining operations that do not fall into the base metal or gold subcategories.

It is not possible to accurately predict the quality of the effluent that would result from the application of any BAT option discussed without first conducting site specific testwork. Each orebody and mineral processing plant is different. A technology applied at one mine may fail completely at another similar mine due to the presence (or absence) of substances found in the various ores or chemicals used in the mining process.

GOLD SUBSECTOR

The greatest diversity of BAT level technology trains, selected by the consultant and the JTC as preferred (best available) technologies, are those that apply to the gold mining/milling subsector. This is principally because of:

- the complexity of cyanide treatment systems which typically provide combined treatment of cyanide and heavy metals

- the common association of arsenic with gold deposits. Arsenic requires a special type of treatment

- the extensive research which has gone into the control of gold milling effluents largely because of the above complexities and the substantial cost of effluent treatment

THE CONSULTANT CONCLUDED THAT WASTEWATER CONTROL TECHNOLOGIES APPLIED TO THE GOLD SUBSECTOR IN ONTARIO ARE CURRENTLY AS SOPHISTICATED AND VARIED AS ANY APPLIED THROUGHOUT THE WORLD.

13 technology trains were identified as being capable of achieving BAT level wastewater control for the Ontario gold subsector. These trains, described in detail in the consultant's report are as follows:

Conventional Technologies for the Removal of Suspended Solids, Cyanide and Heavy Metals

- Natural Degradation (ND) (seasonal discharge with 2-pond system)

- Inco Sulphur Dioxide (on slurry)/Tailings Pond/Polishing Pond

- ND/Inco Sulphur Dioxide/Air/Polishing Pond

- ND/Hydrogen Peroxide/Polishing Pond

- ND/Inco Sulphur Dioxide/Air/Clarification

- ND/Hydrogen Peroxide/Clarification

Technologies for the Removal of Suspended Solids, Cyanide, and Heavy Metals where Arsenic is also Present

- ND/Hemlo Process/Clarification

- ND/Ferric Ion Precipitation/Polishing Pond (seasonal discharge with 2-pond system)

- Inco Sulphur Dioxide-Air/Ferric Ion Precipitation/Tailings Pond/Polishing Pond

- ND/Inco Sulphur Dioxide-Air/Ferric Ion Precipitation/Polishing Pond

- ND/Hydrogen Peroxide/Ferric Ion Precipitation/Polishing Pond

- ND/Inco Sulphur Dioxide-Air/Ferric Ion Precipitation/

Clarification

- ND/Hydrogen Peroxide/Ferric Ion Precipitation/Clarification

The last 7 technology trains are modifications of the 6 basic technology trains specifically adapted for add-on control of arsenic (as well as antimony). 4 of the 13 technology trains are not presently in use but represent rearrangements of proven technology and therefore could readily be used.

All of the technology trains presented above provide progress toward the MISA goal of virtual elimination of toxic compounds but none of the employed technologies are as yet capable of achieving virtual elimination.

Application of the preferred (best available) BAT options that have been noted will enhance the achievability of non-toxic effluents in many cases. Non-lethal effluents have been demonstrated at a number of specific sites where these technologies have been employed.

Base Metal Subsector

The consultant identified 5 technology trains that were capable of providing BAT level treatment for base metal mine effluents. The technology trains were as follows:

- Tailings Pond/Hydroxide Precipitation/Secondary Settling
- Tailings Pond/Hydroxide Precipitation/Clarification
- Tailings Pond/Sulphide Precipitation/Clarification
- Multistage Precipitation/Multistage Clarification
- Underwater Disposal

The first 2 technology trains are standard practice throughout the industry and are practiced in Ontario. To be compatible with US EPA NSPS, wastewater recycle is required to the extent feasible with these trains.

The Tailings Pond/Sulphide Precipitation/Clarification technology train is practiced at one mine/mill in Sweden and one in British Columbia. The sulphide precipitate in Sweden is disposed of underground with the backfill. In British Columbia it is coprecipitated with the tailings. Metal sulphide precipitates are generally unstable when in contact with the atmosphere and react to form water-soluble salts. Unless a suitable method of collection and disposal is available for the reactive sulphide precipitates produced by this technology train, its use is not recommended. If suitable collection and disposal arrangements can be made for the precipitates, sulphide precipitation offers the possibility of much

reduced levels of metals in effluents.

Multistage Precipitation/Multistage Clarification is the most complex and costly of the technology trains listed above. The method involves sulphide precipitation as one of its components and is specifically designed for low volume, concentrated waste streams, derived from stand-alone smelters/refineries. Its current use is limited to selected plants in Germany and Sweden. The sulphide sludge created is treated as a hazardous waste.

Underwater Disposal of massive sulphide tailings is practiced by Hudson Bay Mining and Smelting in Snow Lake, Manitoba and by Cominco at the Polaris Mine in the Northwest Territories. Deep sea disposal is practiced at Island Copper (British Columbia) and in Norway. Technically, the practice is of value because it works to prevent sulphide oxidation (under properly controlled conditions) and therefore limits heavy metal concentrations in the final effluent as well as facilitating mine closure. There are many questions concerning the environmental consequences of underwater mine waste disposal. Consequently, this practice has not been allowed in Ontario for many years.

In general, THE TECHNOLOGIES CURRENTLY BEING USED BY BASE METAL MINES IN ONTARIO FOR POLLUTION CONTROL ARE AT LEAST EQUIVALENT TO, IF NOT BETTER THAN, THOSE BEING USED ON AN INTERNATIONAL BASIS.

The Control of Mining Parameters on a World-Wide Basis

According to the consultant's report, the following parameters (important at mining operations) are regulated on a worldwide basis as follows:

pH

Most operations worldwide are required to achieve final pH values in the range 6.0 to 9.5 , with extreme limits as low as 5.0 and as high as 10.0 .

Suspended Solids

Ontario and Sweden specify a suspended solids limit of 15 mg/litre. Otherwise, 20 to 25 mg/litre is the lower long-term limit used by most countries/regions. Maximum acceptable values generally range from 30 to 50 mg/litre.

Cyanide

Cyanide, on a worldwide basis, is controlled as both total cyanide and weak acid dissociable cyanide. Limits for total cyanide range anywhere from 0.025 to 2.0 mg/litre. Limits set in the United States, typically 5 to 50 mg/litre, are related to wildlife/bird toxicity and to zero volume discharge and, therefore, are not immediately applicable to the situation in Ontario. Gold mining in Europe is virtually non-existent (other than that which is included

with base metal concentrate production). A limit of 0.5 to 2.0 mg/litre for France is shown in the consultant's report. This limit relates to a single mine. The lowest level found, 0.025 mg/litre, for Newfoundland appears to be based on plating industry standards. The one Newfoundland gold mine, Hope Brook, was unable to meet this standard. Hope Brook is currently not operating.

Cadmium and Mercury

Regulated cadmium levels of approximately 0.02 to 0.2 mg/litre are typical of most countries and regions. Ontario's standard of 0.001 mg/litre is markedly more stringent. Regulated mercury levels of 0.001 to 0.005 mg/litre are typical, with those of Germany at 0.05 mg/litre being the least stringent.

Copper

Typical allowable copper concentrations are in the 0.15 to 0.3 range, with some limits above and below this range.

Lead

Long-term average acceptable concentrations for lead are more uniform than those of other parameters. The typical range is 0.2 to 0.3 mg/litre. However, more stringent standards to about 0.05 mg/litre are imposed by British Columbia and Missouri. British Columbia standards apply to the dissolved level (not to the "total" level).

Zinc

Effluent standard levels for zinc are in the general vicinity of 0.5 to 1.0 mg/litre. The lower guideline (0.1) shown in the consultant's report for Sweden represents a desired objective with recognition that this standard may not be achievable in many cases.

Nickel

Nickel limits are typically in the 0.1 to 2.0 mg/litre range. Limits were not set for nickel by the U.S. EPA because there is only one operating nickel mine in the U.S. and because, in the U.S., limits set for copper and zinc are thought to be sufficient to control nickel concentrations.

Arsenic

Regulated long term average acceptable concentrations typically range from 0.1 to 1.0 mg/litre.

PERFORMANCE ASSESSMENT OF TECHNOLOGIES

TECHNOLOGY TRAINS IN PLACE IN ONTARIO (EARLY 1992)

Appendix 2 of this report contains a listing of the technology trains that were in place at Ontario metal mines early in 1992. These technology trains largely produced the effluent results noted in the 12-month MISA database report (previously referred to) for the metal mining sector.

TECHNOLOGY TRAINS IN PLACE AROUND THE WORLD

Section 6 of the consultant's report lists the effluent quality (pH, As, Pb, TSS, Fe, Zn, CN, Cu, Hg, NH3,Ni,Cd) achieved by the various preferred (BAT) technology trains at 66 sites around the world.

DETAIL: THE INCO SO2/AIR CYANIDE DESTRUCTION PROCESS

A common component of many of the available BAT technology trains is the Inco SO2/Air Cyanide Destruction Process. Details of this process including sites of application, chemistry and performance data are given in Appendix 3 of this report.

DETAIL: THE DEGUSSA HYDROGEN PEROXIDE CYANIDE DESTRUCTION TECHNOLOGY

The use of hydrogen peroxide is a common component of many of the available BAT technology trains. Various hydrogen peroxide processes are discussed in the consultant's report. Appendix 4 of this report gives additional performance detail on the Degussa use of hydrogen peroxide at a number of Canadian mine sites.

DETAIL: pH CONTROL USING CARBON DIOXIDE

The pH of mine wastewaters is adjusted by the addition of a base if the pH is too low and by the addition of an acid if the pH is too high. The acid or base can be added as a liquid (e.g. sulphuric acid) or as a slurry (e.g. lime). In many cases, Ontario mine effluents are too alkaline. The pH must be adjusted downwards. The most common chemical used to lower pH in Ontario is sulphuric acid. Sulphuric acid is readily available, is relatively inexpensive and its use is characterized by fast reaction. Sulphuric acid, however, is very corrosive and, as such, worker health and safety factors are a consideration. In addition, spills of sulphuric acid are often difficult and expensive to clean up. The fast reaction time of sulphuric acid necessitates the installation of sophisticated controls to prevent the over neutralization of effluents.

Carbon dioxide, in liquid form, is used to lower the pH of wastewaters at some Ontario mining sites. The liquid is vaporized before being introduced into the wastewater. Carbon dioxide is normally available at a price that is competitive with sulphuric acid. In addition, carbon dioxide is readily available, spills clean themselves up (the liquid simply reverts to a gas that is a normal component of the atmosphere) and , compared to sulphuric acid, health and safety factors are much improved. Carbon dioxide reacts quickly (within 30 seconds) and its chemistry prevents over neutralization. The use of carbon dioxide at Ontario mine sites does not contribute to the greenhouse effect. The carbon dioxide available from the supplier is recovered, for re-use, from existing industrial waste gas streams. Appendix 5 of this report gives additional details concerning the properties and use of carbon dioxide for pH adjustment.

DETAIL: THE USE OF SOLUBLE SILICATES TO CONTROL METALS IN MINE WASTEWATERS

Research based on silicate and lime/silicate combinations has indicated superior metals removal is possible with the use of soluble silicates or soluble silicates/lime combinations at a lower pH value than is possible with lime alone. Essentially, silicate treatment represents an add-on polishing technique that has the ability to reduce effluent metal concentrations. Resulting sludges are thought to be more stable than the sludges produced by conventional treatment strategies. The stated benefits of silicate technology as applied to metals removal are as follows:

- Precipitation of metals may occur at a lower pH range (6.0 to 9.5) (metal hydroxides 8.5 to 11)

- In many existing facilities, metal precipitation must be carried out at pH values in excess of 9.5 in order to meet regulatory requirements. The pH must subsequently be lowered to meet regulatory requirements. In base metal effluents, the use of silicate or lime/silicate combinations may make it possible to meet regulatory requirements at lower pH values and, as such, subsequent pH adjustment may not be required.

  Note: The above comments apply to base metal effluents. That is, effluents in which the metals are dissolved and are not complexed by substances such as cyanide.

- Silicates appear to give high (85 to 99.9 %) removal efficiencies at moderate pH values (8.5) for metals such as copper, nickel, lead and zinc

- Silicates appear to give rise to fast settling flocs

- Silicate sludges may be quite stable due to the formation of insoluble metal silicate complexes

- water soluble silicates (example: sodium silicate) are

non-corrosive and easy to handle

Appendix 6 of this report gives additional preliminary information on the usefulness of water soluble silicates or silicate/lime combinations for the control of copper, nickel, lead and zinc.

DETAIL: THE USE OF VITROKELE CHELATING RESIN TO CONTROL CYANIDE AND METALS IN MINE WASTEWATERS

Tallon Metal Technologies Inc. has developed "Vitrokele", a chelating resin that has the ability to capture metals (including gold) and total and weak acid dissociable cyanides as well as thiocyanate from both slurries and solutions. The loaded resin is eluted and returned to the recovery circuit while metals and cyanide are recovered from the eluent stream. In association with the Ontario Ministry of the Environment, this process was demonstrated at pilot scale at the Hope Brook Gold Mine (B.P. Resources) in Newfoundland and at the Bell Creek Mine (Canamax) near Timmins, Ontario. The results from these pilot programs showed metal and cyanide recoveries of 99 % or more with the concentration of cyanide and metals in the effluents reduced to levels with minimal or no toxicity to rainbow trout. Furthermore, neither cyanate nor ammonia were generated by the process. The loaded resin was effectively stripped and re-introduced to the recovery circuit; cyanide was captured in the eluent stream and made available for recycling to the mill leaching circuit; and metals were captured for re-use, sale or disposal.

Appendix 7 of this report gives additional detailed information concerning the cost and effectiveness of Vitrokele resins.

DETAIL: THE USE OF DIMETHYLDITHIOCARBAMATE TO CONTROL METALS IN MINE WASTEWATERS

Technology is available for the treatment, to low levels, of most common metals. Difficulties are sometimes encountered, however, when the metals to be treated are in a complexed or chelated form. The use of sodium dimethyl or diethyldithiocarbamate has been suggested to overcome the treatment difficulties associated with complexed or chelated metals. Sodium dimethyldithiocarbamate is available for use as an aqueous 40 % solution. Appendix 8 of this report gives additional information on this compound.

THE SELECTED BAT OPTIONS

As previously indicated, the consultant and the Joint Technical Committee concluded that the technology trains currently in place at specific Ontario mining properties are as sophisticated and varied as any applied throughout the world and are equivalent to,

if not better than, those used on an international basis. Consequently, the data found in the 12-month MISA database for the sector along with the additional information found in the various appendicies of this document indicate the performance capabilities of the technology trains. Three clear BAT options emerge:

Option #1:

The Best In North America (in general, the best in the world)

This option generally involves the use of best management practices coupled with long-term waste retention facilities, high rates of wastewater re-use, the use of substances such as sulphur dioxide, carbon dioxide and/or hydrogen peroxide, differential precipitation of metals, natural degradation, ferrous or ferric ion additions and settling.

This option is capable of achieving the following monthly average concentrations:

total suspended solids	15 mg/litre
total cyanide	1 mg/litre
pH	6.0 to 9.5
lead	0.2 mg/litre
copper	0.3 mg/litre
nickel	0.5 mg/litre
zinc	0.5 mg/litre
arsenic	0.5 mg/litre

The technologies included in Option #1 have been installed and are currently operating at several Ontario mine sites.

Option #2

Best Metals Removal

This option consists of many of the technical components of Option #1 but differs from Option #1 in that metals are precipitated as sulphides instead of hydroxides. The advantage is that sulphide precipitation can achieve lower metal levels than those achieved by hydroxide precipitation. Effluent metal concentrations at or below 0.1 mg/litre can sometimes be achieved.

Note: The term "Best Metals Removal" refers to technology that has been demonstrated on a commercial scale at operating mines in the mining industry. Developing technologies such as "Vitrokele" and silicate precipitation, when commercialized, would probably fall into the "Option #2" category.

There is a significant difficulty with sulphide precipitation. While sulphide sludges are essentially insoluble, sulphides themselves, in contact with the atmosphere, are readily oxidized to sulphates. Copper, nickel and zinc sulphates are highly soluble

in water. For this reason, sludge disposal in an oxygen-free environment is normally required. Some sulphide sludges could be reprocessed in a smelter if a smelter is available and if the metallury of the sludge did not adversely impact on smelter operations.

Option #3

Zero Discharge

In metal mining, zero discharge is more properly referred to as "zero volume discharge". Zero volume discharge implies that wastewater is not discharged from the operation. With no effluents, zero discharge of contaminants (in wastewater) is achieved.

Most metal mines in the United States practice zero volume discharge. This is possible because most U.S. metal mines are in arid or rainshadow areas. In Ontario, even with high rates of re-use of wastewaters, zero volume discharge is not possible except through the forced evaporation of the effluents.

THE IMPACT OF THE TECHNOLOGY OPTIONS ON THE TOXICITY (TO RAINBOW TROUT AND DAPHNIA MAGNA) OF ONTARIO METAL MINING EFFLUENTS

Option #3

Option #3 would eliminate all Ontario metal mining wastewater effluents. As such, toxicity of these effluents would become a none-issue.

Option #2

There is only limited operating data available for option #2. The use of sulphide precipitation is especially suited to the treatment of high strength (elevated metal levels) smelter/refinery wastewaters. The precipitate, in many cases, can be recycled to the smelting process to eliminate sludge disposal difficulties. Sulphide precipitation is also employed at certain minesites where particularly low levels of specific metals must be attained and/or where precipitation at low pH levels is desirable. It is necessary to note that precipitation of metals as sulphides is most effective in the pH range 4 to 5. In Ontario, in almost all cases involving the need for extended metals control, pre and post-pH adjustments would have to be carried out. This could result in increased levels of dissoved solids in the effluents, the addition of anions and/or cations not originally present in the effluents and the increased risk of toxicity due to equipment failure of the pH adjustment system itself. In addition, metals in gold industry effluents are generally present as metal-cyanide complexes or exist in cyanide-bearing solutions. pH adjustment of these wastes to the acid range

required for optimum precipitation of metals using soluble sulphides would, in all probability, generate lethal amounts of hydrogen cyanide gas.

In those cases where the metals are dissolved and do not exist as stable complexes, sulphide precipitation may achieve metal levels at or below 0.1 mg/litre. The current MISA database indicates that in approximately 42 % of the effluents sampled, copper in concentrations above 0.1 mg/litre was a suspected source of toxicity. As a consequence, sulphide precipitation could be useful for toxicity reduction in selected effluents (particularly base metal effluents). In addition, various combinations of copper, nickel and zinc were suspected sources of toxicity in approximately 65 % of the effluents sampled. Again, however, 20 % of these effluents involved metals in association with cyanide.

The use of the sulphide metals precipitation train may reduce toxicity due to copper, nickel and zinc (and other heavy metals) in selected cases. Unless properly handled, the sludge from the process could give rise to toxicity problems. Residual sulphide from the treatment process itself could give rise to toxicity problems.

Option #1

As stated previously, Option #1 is capable of achieving the following monthly average concentrations:

suspended solids	15 mg/litre
total cyanide	1 mg/litre
pH	6.0 to 9.5
lead	0.2 mg/litre
copper	0.3 mg/litre
nickel	0.5 mg/litre
zinc	0.5 mg/litre
arsenic	0.5 mg/litre

Option #1 technology trains can produce the above concentrations at both gold and base metal operations. It is important to note that, in the case of the metal mining sector, suspected causes of toxicity are largely attributed to the following:

elevated pH levels	(in excess of 9.5)
copper	(in excess of 0.1 mg/litre)
nickel	
zinc	
suspended solids	(containing particulate metals)
ammonia	
arsenic	

While Option #1 technology trains can produce the concentrations noted, the consultant's report and the data contained in the appendicies to this report clearly indicate that, on a case-by-case basis, much better results can be achieved. In fact, in order to be in compliance with the metal mining limits regulation, concentrations below those noted will have to be achieved on a consistent basis. Option #1 technology trains are capable of doing this. As a consequence, the application of BAT Option #1 to Ontario metal mine effluents should substantially resolve existing toxicity problems that are due to pH, metals, arsenic and suspended solids. As with all other options, residual toxicity may persist in some instances due to the presence in effluents of ammonia (for which no economic treatment could be found), the antagonistic and synergistic effects of various combinations of substances, unexpected biological or chemical oxygen demands, unusual temperature variations, unstable sulphur species and so forth.

The consultant's study of Best Available Technology (BAT) was not able to critically assess the ability of the technologies reviewed to meet the required toxicity criteria for trout and Daphnia. The primary reason was the lack of information in the literature. Toxicity data collected for 12 months under the MISA monitoring regulation showed that about half of the metal mining effluents failed at least one toxicity test. However, the lack of conclusive information on the causes of toxicity prevented a definitive analysis of which technologies should be applied to reduce the toxicity of specific effluents. The Joint Technical Committee therefore recognized that a means of relieving direct dischargers from some aspects of the effluent toxicity requirements may be required in those cases where BATEA has been installed, all other BATEA limits or requirements have been met and the effluent is still toxic. In the foregoing discussion of the various BAT options and their potential to achieve the stated toxicity criteria, best professional judgement was used.

ECONOMIC ASSESSMENT (EA)

In order to develop effluent limits based on the best available technology economically achievable (BATEA), the Ministry conducted an economic assessment of the cost effectiveness and financial implications of applying potential technology train options to each plant in the metal mining sector.

The Economic Assessment Working Group

An Economic Assessment (EA) Working Group was formed under the auspices of the MISA Metal Mining Sector Joint Technical Committee to recommend to the JTC the best available technology economically achievable for the Metal Mining Sector. The EA Working Group originally consisted of representatives from the Ministry of the

Environment, Northern Development and Mines, Environment Canada and industry. As meetings progressed, it became apparent that the EA Working Group could not function effectively in isolation from other working groups. As a consequence, a single large working group eventually evolved that handled most aspects of EA, limits setting, technology evaluation and selection, data management and report and regulation writing.

The main working group (taking the place of the EA Working Group) was assigned the task of collecting the data necessary to conduct the economic impact assessment and developing necessary procedures, methodologies and assumptions for the assessment of the technology train options (#1, 2 and 3) that were available.

Objectives Of The Economic Assessment

The primary objectives of the economic assessment were:

- to evaluate the cost-effectiveness of potential wastewater treatment and abatement program options
- to show the incremental costs of successively higher levels of contaminant removal, and
- to assess the potential financial and economic consequences of the costs associated with potential abatement program options that are cost-effective and other MISA related costs that may be incurred by the regulated plants

Abatement Cost Functions

The cost estimates of the identified BAT technology train options and the contaminant removals associated with each option were used to derive abatement cost functions (the primary analytical tools used in the economic analysis).

Abatement cost functions show the costs of different technology train option combinations that are associated with successively higher levels of contaminant reduction.

Where more than one combination of technologies will achieve the same level of contaminant removal at different costs, the least cost combination of technologies is used in the derivation of the cost functions. The determination of least-cost combinations is a necessary prerequisite to any financial assessment of abatement costs as they apply to the regulated plants, firms or sector.

After technically "achievable" least-cost levels of abatement are identified, the next step is to ascertain those technically feasible technology trains that are the most cost effective according to:

- the cost per unit of pollutant removed (the lower the cost per unit of pollutant removed, the more cost effective the option)

- the average incremental cost for each additional unit of pollutant removed in achieving successively higher levels of contaminant reduction in the effluent (the lower the ratio of average incremental cost per incremental unit of pollutant removed, the more cost-effective the option)

The economic assessment focused on three limit options as follows:

- Option #1: Best In North America (in general, Best In The World)
- Option #2: Best Metals Removal
- Option #3: Zero Discharge

Reductions in total loadings for the seven contaminants to be limited were estimated to be:

- Option #1: 31 %
- Option #2: 34 %
- Option #3: 100 %

The cost per kilogram removed was estimated to be as follows:

- Option #1: $3.90
- Option #2: $43.66
- Option #3: $542.83

Option #1 was selected by the Metal Mining Joint Technical Committee as BATEA. Option #1 was determined to be the most cost-effective option and analysis of the financial implications of imposing the MISA related costs of Option #1 on Ontario mines indicates that the effect on financial performance would be small to negligible. Analysis, however, did indicate that firms would not be able to pass on increased costs as higher metal prices as metal prices are largely determined by international markets.

Option #1 technologies are proven in that, many examples of the most important components that make up Option #1 technologies have been installed and are operating in many countries around the world. In addition, most of these technologies have been installed and are operating in various places within the Province of Ontario or in Canada. The very fact that these technologies have been installed and have been used by the international industry for

periods of months or years indicates that these technologies can be or are integral components of profitable mining operations.

Economic assessment details are found in Appendix 9 of this report.

The Effluent Limits

Chapter Five

of the

Development Document

THE EFFLUENT LIMITS

Limits for operating Ontario metal mines were developed by the JTC Limits Setting Working Group. However, as explained in Chapter Four of this document, it became apparent that a single-purpose working group in the metal mining sector could not function effectively in isolation from other working groups. As a consequence, a single large working group eventually evolved that handled most aspects of EA, limits setting, technology evaluation and selection, data management and report and regulation writing. The membership of the group closely reflected that of the JTC itself. On a day-to-day basis, membership varied according to the topic or topics being discussed.

The Limits Setting Working Group (main working group) had the following tasks:

- to identify the types of effluent streams to be limited
- to define the type of limits to be put in place (concentration, loading, daily, monthly, production based)
- to produce a list of parameters to be limited
- to derive numerical limits based on selected Best Available Technology (BAT)

The Types Of Effluents To Be Limited

Under the MISA Effluent Monitoring Regulation for the metal mining sector, the following types of effluent streams were monitored at various frequencies and for various parameters:

- Minewater Effluent
- Process Effluent
- Smelter/Refinery Effluent
- Storm Water Effluent

Under the MISA effluent limits regulation, discharge limits will be imposed only on Process Effluents since these effluents contribute most of the contaminant loadings in the sector. For purposes of clarification, however, it is necessary to understand that Process Effluent, as defined in the metal mining sector limits regulation, includes tailings area discharges, blowdown from recirculating cooling water systems, minewater effluent, smelter/refinery effluent and any effluent that originates from or comes into contact by design with any industrial process or process materials and includes continuous and intermittent discharges.

Cooling Water Effluent and Emergency Overflow Effluent in the sector will not be limited but will be monitored for assessment. The assessment data can be used, if necessary, to develop suitable

control programs for these streams. In the metal mining sector, cooling water effluents are not common. In addition, emergency overflow effluents occur at most properties perhaps once every 10, 20, 30 or 40 years.

The Form/Type Of Effluent Limits

Effluent limits can be expressed as loading limits, production-based loading limits or concentration limits. They can be set on a daily or monthly average basis.

Effluent limits for the metal mining sector developed under the MISA program are expressed as concentrations. Concentrations are independent of flow and production.

A detailed explanation of why the metal mining sector effluent limits are expressed in terms of concentrations rather than loadings is given in Appendix 10 of this document.

The List Of Parameters To Be Limited

The list of parameters that are considered for effluent limits consists of those parameters that can be controlled by the defined BAT(EA). Under special circumstances, parameters such as tetrachlorodibenzo-p-dioxin which pose a significant threat to human health and the environment may be limited regardless of the availability of economic treatment technology.

In general, limits are set on a short list of easy-to-measure toxic and conventional parameters. This is based on the assumption that compliance with the requirements of the short list will correlate with the control of a longer list of contaminants of concern. For the metal mining sector, effluent limits have been developed for suspended solids, total cyanide, arsenic, copper, nickel, lead and zinc. An integral part of the regulation package involves the strict control of pH and a requirement for non-toxic full-strength effluents.

The Derivation Of Numerical Limits

The identification of generic technology trains and the identification of associated performance data were fundamental to the development of the effluent limits for the metal mining sector. Technology train performance data, as described in Chapter Four of this document, was applied to the parameters selected for limits. The long term average (LTA) concentrations and variability factors were calculated in agreement with procedures accepted by the MISA office.

Although the metal mining sector effluent limits are based on concentrations, loadings were calculated for all plants in the

sector so that loading comparisons on a parameter-by-parameter basis could be made with other industrial sectors and with other plants in the sector. In the metal mining effluent monitoring regulation, flows were measured and recorded at the time of sampling. As a consequence, loading calculations were done for each sample taken and the concentration measured for each sample was used in the calculation of the loading. The average annual loading was based on an average of the sum of all loadings calculated over the year for a particular effluent stream. In general, each average annual loading recorded was based on between 100 and 150 individual samples and calculations. The annual loadings were also based on the actual number of days that a specific effluent was discharged over the sampling period (12 months).

LIST OF PARAMETERS FOR LIMITS

The following steps were used to determine which parameters would be limited:

- the effluent monitoring data were analyzed in order to determine the parameters which were statistically present in the effluent
- parameters identified as being statistically present in the effluent were determined as a result of the use of rigorous Quality Assurance/Quality Control (QA/QC) data assessment procedures
- the ability of identified BAT technology train options to treat the parameters remaining after QA/QC data assessment was determined
- "special" parameters (that pose a significant threat to human health and the environment) were assessed in order to determine if they should be added to the limits list

Preliminary Selection Of Candidate Parameters

In order to select the parameters for limits, a selection criterion based on the 90/10 rule was applied to the 1990/91 MISA monitoring data for the sector. Parameters were not considered further if the effluent monitoring data showed (at a 95% confidence level) that 90% of the data were at concentrations less than the Regulation Detection Limit (RMDL).

The preliminary selection of parameters through application of the above rule produced a list of 58 parameters (see Table 1: page 176 of the Status Report; Metal Mining Sector Effluent Monitoring Data; February 1, 1990 to January 31, 1991).

QA/QC Assessment Of Monitoring Data

Each parameter appearing on the preliminary selection list was subjected to QA/QC assessment. The validity of analytical results was determined through analysis of blanks, travelling blanks, travelling spiked blanks and duplicate sample analytical results. Details of the QA/QC analysis of the metal mining sector monitoring database are given in the database report mentioned above.

Of 58 parameters appearing on the preliminary selection list, 42 remained after QA/QC assessment. They were as follows:

- COD (chemical oxygen demand)
- Total Cyanide
- Total Phosphorus
- Total Suspended Solids
- Aluminum
- Cadmium
- Chromium
- Cobalt
- Copper
- Lead
- Molybdenum
- Nickel
- Zinc
- Antimony
- Arsenic
- Selenium
- Mercury
- Phenolics (4AAP)
- Carbon Tetrachloride
- Chloroform
- Methylene Chloride
- Benzene
- Toluene
- m-Xylene and p-Xylene
- o-Xylene
- 2-Methylnaphthalene
- Naphthalene
- m-Cresol
- p-Cresol
- Oil and Grease
- Ammonia plus Ammonium
- Total Kjeldahl Nitrogen
- Nitrate plus Nitrite
- TOC (total organic carbon)
- Chlorides
- Cyanates (filtered)
- Dissolved Solids
- Sulphates
- Iron
- Thiocyanates (filtered)
- Uranium
- Cyanide (weak acid dissociable)

Each parameter listed above potentially could appear as a limited parameter in the metal mining sector regulation. As a consequence, each parameter was reviewed. Review criteria included:

- the frequency of occurrence of the parameter in metal mining sector effluents
- the average concentration of the parameter in metal mining sector effluents
- the source of the parameter
- the limitation of the parameter in other jurisdictions
- availability of BATEA for removal of the parameter and the removal capability of the BATEA
- availability of reliable analytical methods to measure the parameter at the levels being encountered
- the environmental consequences of the presence of the parameter in mining effluents

The results of the reviews are as follows:

COD (CHEMICAL OXYGEN DEMAND)

Chemical oxygen demand measures the amount of oxygen consumed in an effluent sample based on the rapid chemical oxidation of the sample.

Chemical oxygen demand was found in 86% of the metal mining effluent streams sampled.

The average concentration of chemical oxygen demand measured in the metal mining sector effluents was 23 mg/litre (RMDL=10mg/litre).

Metal mining sector effluents are largely inorganic in nature. Most effluents are held, in contact with the atmosphere, for days, weeks or months. Most effluents are alkaline. Chemical oxygen demand may be due to to the presence of unoxidized oxidizable metals, cyanide, ammonia or substances such as unstable sulphur species (example: thiosalts).

A mining effluent that gives rise to a continuous oxygen demand in a specific receiver could locally exhaust all available oxygen in the receiver and could result in local anaerobic conditions. On a case-by-case basis, chemical oxygen demand should always be investigated as a potential source of receiver impairment.

Data available at the present time suggests that metal mining effluents on a worldwide basis are not subject to limits for chemical oxygen demand.

Treatment for chemical oxygen demand is potentially available. On a case-by-case basis, the cause of the oxygen demand would have to be determined and the appropriate technology applied. Many substances in metal mining effluents that ultimately give rise to an oxygen demand in a receiver are somewhat stable in alkaline environments. Suitable treatment would normally involve acidification of the effluent followed by active or passive aeration.

The RMDL (10 mg/litre) for chemical oxygen demand is relatively high.

Because the chemical oxygen demand of metal mining effluents has not been widely identified to-date as an environmental concern, chemical oxygen demand was not considered further for effluent limits setting. On a case-by-case basis, the impact of chemical oxygen demand on a receiver may be significant and appropriate treatment should be provided when and where necessary.

Chemical oxygen demand was not considered further for effluent limits setting.

TOTAL CYANIDE
WEAK ACID DISSOCIABLE CYANIDE

For the purposes of this report, the term "total cyanide" includes all simple and complexed forms of cyanide with the exception of gold and cobalt cyanide complexes. "Weak acid dissociable cyanides" do not include gold, cobalt or iron cyanide complexes.

The relationships between total and weak acid dissociable cyanides and the precise analytical methods that are employed to detect each are explored in a colour video that was jointly produced by Environment Canada and the Ontario Ministry of the Environment. The video, entitled "Total and Weak Acid Dissociable Cyanide Methods of Analyses", can be obtained at the following address:

Environment Canada
Wastewater Technology Centre
Laboratory Services Division
P.O. Box 5068
867 Lakeshore Road

Burlington, Ontario (Canada)
L7R 4L7

In general, most (not all) simple and complexed cyanides impart toxicity to metal mining effluents. Some cyanide complexes are more toxic than others. When mining operations use cyanide as a process chemical, resulting effluents generally contain a mixture of simple and complex cyanides. The cyanide complexes often involve zinc, copper and nickel.

Total cyanide was found in 54% of the metal mining effluent streams sampled. Weak acid dissociable cyanides were found in 32% of the metal mining effluent streams sampled.

The average concentration of "total cyanide" (RMDL=.005 mg/litre) measured in the metal mining sector effluents was as follows:

gold mining effluents	.084 mg/litre
base metal effluents	.006 mg/litre

Cyanide is used in very small amounts in base metal operations. The low level of "total cyanide" in the base metal effluents reflects this fact. Base metal effluents are not treated for cyanide although some cyanide degradation should occur during the normal handling of these wastes. Gold operations generally use substantial quantities of cyanide to recover gold from its ore. The low concentration of "total cyanide" in gold mining effluents noted above reflects the fact that most Ontario gold mines already have in place effective treatment strategies for cyanide.

The average concentration of "weak acid dissociable cyanide" (RMDL=.005 mg/litre) measured in the metal mining sector effluents was as follows:

gold mining effluents	.026 mg/litre
base metal effluents	.006 mg/litre

Metal mining effluents on a worldwide basis are subject to limits for cyanide. The form of the limits varies from jurisdiction to jurisdiction.

A number of demonstrated treatment technologies are available for cyanide control in effluents.

Cyanide was considered for limits setting.

TOTAL PHOSPHORUS

Phosphorus was found in 24% of the metal mining effluent streams sampled.

The average concentration of phosphorus measured in metal mining effluents was .1 mg/litre (RMDL=.1 mg/litre).

In many metal mining effluents, phosphorus is found as suspended particles of calcium phosphate (the mineral apatite). As such, phosphorus control can largely be achieved by the control of suspended solids. In cases involving effluents that contain phosphorus in a soluble form, control may be achieved by the addition of substances such as lime with subsequent settling.

A mining effluent that results in a continuous discharge of phosphorus to a receiver could promote the growth of algae and other plant life in the receiver. Under some circumstances, the biomass could overwhelm local areas of the receiver.

Phosphorus is not regulated in most mining jurisdictions worldwide. If needed, demonstrated treatment technology is available. Control of suspended solids will, in most cases, control phosphorus.

Because of the low levels of phosphorus measured in Ontario metal mining effluents, phosphorus was not considered further for effluent limits setting.

TOTAL SUSPENDED SOLIDS

Total suspended solids were found in 80% of the metal mining effluents sampled.

The average concentration of total suspended solids measured in the metal mining sector was 7 mg/litre (RMDL=5 mg/litre).

Suspended solids in metal mining effluents are largely composed of naturally occurring silicates, oxides, carbonates and sulphates. However, suspended solids in metal mining effluents also commonly contain particles of the substances that are being mined and may be contaminated with chemicals used in mining or milling processes.

Metal mining effluents that contain suspended solids may:

- colour local areas of a receiving stream
- contaminate the sediments of a receiving stream
- destroy valuable fish habitat

Demonstrated technology for the control of suspended solids in metal mining effluents is available on a worldwide basis.

Suspended solids in metal mining effluents are regulated on a worldwide basis.

Suspended Solids was considered for effluent limits setting.

ALUMINUM

Aluminum was found in 70% of the metal mining effluents sampled.

The average concentration of aluminum measured in the metal mining sector was .20 mg/litre (RMDL=.03 mg/litre).

Aluminum in mining sector effluents is largely present in particulate form (suspended solids). Many of the rocks and minerals associated with ore deposits are simple or complex aluminum silicates and oxides. These materials are a common component of tailings from many mining operations. Dissolved aluminum is not a significant component of most metal mining effluents.

Aluminum in Ontario metal mining effluents can be controlled in most cases by increasing control of suspended solids.

Aluminum is controlled in British Columbia within the range (guidelines) of 0.5 to 1.0 mg/litre (the lower limit is for new plants; the high limit is for older plants). In addition, Italy regulates aluminum at 2 mg/litre and Spain regulates aluminum at between 1 and 2 mg/litre. As far as is known, aluminum is not regulated in any other mining jurisdiction worldwide.

Aluminum was not considered further for effluent limits setting.

CADMIUM

Cadmium was found in 12% of the metal mining effluents sampled.

The average concentration of cadmium measured in the metal mining sector was .003 mg/litre (RMDL=.002 mg/litre).

In many Ontario metal mines, cadmium is found associated with sphalerite (a common ore mineral of zinc). The cadmium actually occurs within the sphalerite (zinc sulphide) crystal structure. In some instances, cadmium occurs in Ontario ores as discrete grains or masses of cadmium sulphide. When zinc in an effluent is found as particles (suspended solids) of sphalerite, cadmium can be controlled by controlling suspended solids. If the cadmium is present in a dissolved form or is complexed with cyanide, control is more difficult but can be achieved, at least in part, using cyanide control technologies which also control metal levels or by using a variety of available precipitants.

In Ontario, levels of cadmium as low as .001 mg/litre have been applied to metal mining industry effluents in Certificates of Approval. Guidelines for cadmium in British Columbia fall within the range .01 to .1 mg/litre. In Newfoundland, cadmium is limited at .05 mg/litre. In the U.S., cadmium in metal mining effluents is limited to .05 mg/litre (average) and .10 mg/litre (maximum). In other mining jurisdictions worldwide, cadmium is limited within a range of .02 mg/litre to .5 mg/litre.

Demonstrated specific treatment technology for cadmium in the metal mining sector was not found. In the cases examined, cadmium removal occurred as a result of technology being applied for the removal of another parameter. None of these technologies (described fully in the consultants best available technology report) are capable of economically achieving cadmium levels in the .001 to .003 mg/litre range.

The toxic properties of cadmium have been well documented. Cadmium levels in effluents should be kept as low as is practicable.

Because of the limited occurrence of cadmium in Ontario metal mining effluents and because of the low levels detected in Ontario metal mining effluents, cadmium was not considered further for effluent limits setting.

CHROMIUM

Chromium was found in only 2% of the metal mining effluents sampled.

The average concentration of chromium measured in the metal mining sector was .008 mg/litre (RMDL=.02 mg/litre).

In most metal mining effluents in Ontario, chromium is found as a component of the suspended solids and exists as a stable combined oxide of chromium and iron (chromite).

Because of the limited occurrence of chromium in Ontario metal mining effluents and because of the low levels of chromium in these effluents, chromium was not considered further for effluent limits setting.

COBALT

Cobalt was found in 38% of the metal mining effluents sampled.

The average concentration of cobalt measured in the metal mining sector was .02 mg/litre (RMDL=.02 mg/litre).

Cobalt is often found in orebodies in combination with sulphur and/or arsenic and iron.

In Canada, cobalt is limited (in the form of guidelines) in metal mining effluents in British Columbia at .5 mg/litre (new plants) and 1.0 mg/litre (older plants). Elsewhere in Canada, the U.S. and the international metal mining community, cobalt does not appear to be limited.

No demonstrated economic technology for the specific removal of cobalt from metal mining effluents was found. Technologies (example: lime treatment) for the removal of dissolved iron from metal mining effluents appear to be effective for cobalt removal.

Because of the low levels of cobalt measured in Ontario metal mining effluents, cobalt was not considered further for effluent limits setting.

COPPER

Copper was found in 78% of the metal mining effluents sampled.

The average concentration of copper measured in the metal mining sector was .07 mg/litre (RMDL=.01 mg/litre).

Chalcopyrite (a copper/iron sulphide) is a common ore mineral in Ontario. Particles of chalcopyrite may be present in some metal mining effluents. In other effluents, copper may be dissolved as specific ions or may be complexed with substances such as cyanide. A large number of copper minerals are known and, at any particular mine, any one of these minerals may be an important source of copper.

Copper is limited in other metal mining jurisdictions on a worldwide basis. Regulated levels in the .1 to .6 mg/litre range are common.

Technology for the control of copper in metal mining effluents has been demonstrated on a worldwide basis.

The toxic properties of copper have been well documented.

Copper was considered for effluent limits setting.

LEAD

Lead was found in 20% of the metal mining effluents sampled.

The average concentration of lead measured in the metal mining sector was .02 mg/litre (RMDL=.03 mg/litre).

Galena (lead sulphide) is a common ore mineral in Ontario. Silver is frequently associated with galena. Galena is heavy. Its weathering products are only sparingly soluble in water. In Ontario metal mining effluents, lead is normally found in the form of suspended solids. Soluble lead readily reacts with many common components of metal mining effluents to form precipitates.

Lead is regulated in almost all metal mining jurisdictions worldwide. The common range of regulation is from .2 to .6 mg/litre.

The toxic properties of lead have been well documented.

Although average lead levels in Ontario metal mining effluents are low, tailings areas associated with lead mining operations often contain quanities of lead that were missed by the milling process. As a consequence, failure of a tailings area, erosion of a tailings area and storm events including high winds over a tailings area can result in lead losses to the environment.

Lead was considered for limits setting.

MOLYBDENUM

Molybdenum was found in 14% of the metal mining effluents sampled.

The average concentration of molybdenum measured in the metal mining sector was .05 mg/litre (RMDL=.02 mg/litre).

Molybdenite (molybdenum sulphide) is found as a minor component of some Ontario ore deposits. At the present time, recoverable amounts of molybdenite occur at a few Ontario gold mines. On a site-specific basis, molybdenum may occur in metal mining effluents in the form of suspended solids or in a dissolved form.

In British Columbia, molybdenum is regulated (in guideline form) at .5 mg/litre for new mines and up to 5 mg/litre for older mines. Molybdenum does not appear to be regulated in any other metal mining jurisdiction in the world.

In the literature, molybdenum has not received great attention as a toxic element. Its function as a micronutrient has been well documented.

Specific economic treatment technology for molybdenum was not identified in the consultant's BAT report.

Molybdenum was not considered further for effluent limits setting.

NICKEL

Nickel was found in 68% of the metal mining effluents sampled.

The average concentration of nickel measured in the metal mining sector was .14 mg/litre (RMDL=.02 mg/litre).

Nickel, in combination with iron and sulphur is found in many Ontario metal ore deposits. Nickel in metal mining effluents may be found as descrete particles of the various nickel minerals or may be in solution.

With the exception of the U.S., nickel in metal mining effluents is regulated on a worldwide basis. Nickel is commonly regulated within the range .2 to 1 mg/litre.

The environmental impacts of nickel have been well documented.

Treatment technology for the removal of nickel from metal mining effluents has been demonstrated on a worldwide basis.

Nickel was considered for effluent limits setting.

ZINC

Zinc was found in 76% of the metal mining effluents sampled.

The average concentration of zinc measured in the metal mining sector was .07 mg/litre (RMDL=.01 mg/litre).

Sphalerite (zinc sulphide) is the most common zinc mineral in Ontario metal ore deposits. Zinc in metal mining effluents may be found as discrete particles of zinc minerals or in solution. Zinc sulphate, an oxidation product of sphalerite, is soluble in water. In addition, zinc forms complexes with cyanide.

Zinc is regulated in metal mining jurisdictions worldwide. The common range of regulation is .2 to 1 mg/litre.

The toxic properties of zinc in metal mining effluents have been well documented.

Treatment technology for the removal of zinc from metal mining effluents has been demonstrated on a worldwide basis.

Zinc was considered for effluent limits setting.

ANTIMONY

Antimony was found in 8% of the metal mining effluents sampled.

The average concentration of antimony measured in the metal mining sector was .035 mg/litre (RMDL=.005 mg/litre).

Antimony is generally found in Ontario metal orebodies in association with sulphur. In effluents, antimony may be found as discrete particles of antimony minerals or in solution.

In British Columbia, antimony is regulated (guidelines) within the range of .25 mg/litre (new mines) to 1 mg/litre (older mines). Antimony does not appear to be regulated in any other metal mining jurisdiction worldwide.

Technology (ferric ion precipitation step: see consultant's best available technology report) is available to remove antimony from metal mining effluents on a site specific basis.

In the literature, antimony has not received great attention as a toxic element.

Because of the limited occurrence of antimony in Ontario metal mining effluents and because of the low levels of antimony in these effluents, antimony was not considered further for effluent limits setting.

ARSENIC

Arsenic was found in 26% of the metal mining effluents sampled.

The average concentration of arsenic measured in the metal mining sector was .036 mg/litre (RMDL=.005 mg/litre).

In Ontario metal mines, arsenic generally occurs in combination with iron and sulphur (arsenopyrite). In local but important instances, arsenic occurs in combination with sulphur and metals such as cobalt and nickel. In other cases, arsenic is found as an oxide. In some cases, arsenic in Ontario metal mining effluents is found as discrete particles of arsenic minerals. In most cases, however, arsenic is found in a dissolved form.

Arsenic in metal mining effluents is regulated on a worldwide basis. The most common range of regulation is .1 to 1 mg/litre.

Technology for the control of arsenic in metal mining effluents

has been demonstrated on a worldwide basis.

The toxicity of arsenic is well documented.

Arsenic was considered for effluent limits setting.

SELENIUM

Selenium was found in 10% of the metal mining effluents sampled.

The average concentration of selenium measured in the metal mining sector was .007 mg/litre (RMDL=.005 mg/litre).

In Ontario metal mines, selenium commonly occurs in association with sulphur.

With the exception of British Columbia (where selenium in guideline form is regulated at .05 mg/litre for new mines and .5 mg/litre for older mines), selenium is not regulated in any metal mining jurisdiction worldwide.

In the metal mining sector, specific practicable technology for the removal of selenium from effluents has not been demonstrated.

In the literature, selenium has received attention as a toxic substance. The exact nature of the toxicity of selenium has not been well defined.

Because of the limited occurrence of selenium in Ontario metal mining effluents and because of the low concentrations of selenium measured in these effluents, selenium was not considered further for effluent limits setting.

MERCURY

Mercury was found in 14% of the metal mining effluents sampled.

The average concentration of mercury measured in the metal mining sector was .0002 mg/litre (RMDL=.0001 mg/litre).

Free mercury is not widely used in the Ontario metal mining industry. Where it is used (at a limited number of gold operations), free mercury does not appear to have a significant impact on effluent mercury concentrations. Traces of mercury are found in association with sulphide mineralization (the most common form of mineralization in Ontario) at most Ontario metal mining sites. Traces of mercury in metal mining effluents are thought to be due to the presence, in general, of discrete particles of sulphide minerals (including the mercury sulphide mineral called

cinnabar) in the effluents.

On a worldwide basis, the regulation of mercury in metal mining effluents is erratic. Where mercury is regulated, the common range of regulation is from .001 to .050 mg/litre.

The toxicity of mercury is well documented.

On a worldwide basis, there does not appear to be a practicable demonstrated technology for the specific removal of mercury from metal mining effluents.

Because of the limited occurrence of mercury in Ontario metal mining effluents and because of the low concentrations of mercury measured in these effluents, mercury was not considered further for effluent limits setting.

PHENOLICS (4AAP)

Phenolics (as measured by the 4-aminoantipyrine test) were found in 50% of the metal mining effluents sampled.

The average concentration of phenolics (4AAP) measured in the metal mining sector was 5 ug/litre (RMDL=2 ug/litre).

The 4-aminoantipyrine test is a colorimetric test that is routinely used to detect hydroxybenzene compounds (phenolic compounds) in aqueous samples. The test has a limited capability to accurately measure the actual (true) concentration of phenolic compounds in aqueous samples. In fact, many of the speciated forms of phenol are inadequately measured or not detected at all by the 4AAP test.

Phenolic compounds can be of natural and man-made origin. In addition to their production and/or use by industry, a wide variety of phenolic compounds can be formed in nature as minor constituents of essential oils (odoriferous oily products of plant origin). Naturally occurring phenolics can also be formed through the decomposition of plant matter.

The range of aquatic toxicity for phenolic compounds is very wide. Some phenolic compounds are toxic at less than one milligram per litre while the toxicity of others exceeds several hundred milligrams per litre.

Phenolic speciation is a test method used to identify individual phenolic compounds in aqueous samples. The 4AAP test does not speciate phenolics. To effectively evaluate the potential environmental effects of phenolic compounds, it is necessary to identify the individual phenolic species that may exist in an effluent.

While there is no doubt that limited quantities of substances that contain phenolics are used by the Ontario metal mining industry on a case-by-case basis, there is equally no doubt that substantial amounts of the phenolics detected in Ontario metal mining effluents have a natural origin. Runoff from heavily forested and swampy areas commonly gains access to tailings areas and mine workings.

Specific practicable technology for the removal of 4AAP phenolics from Ontario metal mining effluents has not been demonstrated within the sector.

Because of the low levels of 4AAP phenolics that, in general, occur in Ontario metal mining effluents and because of the lack of specific practicable technology for the removal of 4AAP phenolics from effluents within the sector, 4AAP phenolics were not considered further for effluent limits setting.

CARBON TETRACHLORIDE

Carbon tetrachloride was found in one metal mining effluent in Ontario. The average concentration in the effluent at the property was 8.3 ug/litre (RMDL=1.3 ug/litre). The source of the carbon tetrachloride could not be determined. The property is no longer active.

Carbon tetrachloride is not regulated in any metal mining jurisdiction worldwide.

Carbon tetrachloride was not considered further for effluent limits setting.

CHLOROFORM

Chloroform was found in two metal mining effluents in Ontario. The average concentration of chloroform in the effluents was 1.6 ug/litre (RMDL=.7 ug/litre). The source of the chloroform could not be determined. Practicable treatment technology for the removal of chloroform from metal mining sector effluents has not been demonstrated.

Chloroform is not regulated in any metal mining jurisdiction worldwide.

Chloroform was not considered further for effluent limits setting.

METHYLENE CHLORIDE

Methylene chloride was found in one metal mining effluent in Ontario. The average concentration of methylene chloride measured in the effluent was 5.7 ug/litre (RMDL=1.3 ug/litre). Ore has been exhausted at the property and the property is no longer active. The source of the methylene chloride could not be determined.

Methylene chloride is not regulated in any metal mining jurisdiction worldwide.

Methylene chloride was not considered further for effluent limits setting.

BENZENE

Benzene was found in two mining effluents in Ontario. The average concentration of benzene found at one of the properties was 2.7 ug/litre (RMDL= .5 ug/litre). Ore at this property has been exhausted and the property is no longer active. The average concentration of benzene found at the other property was 16 ug/litre. The source of the benzene could not be determined. The most probable source would be an organic cleaner or de-greaser that contains benzene.

No specific practicable treatment technology for benzene in metal mining effluents could be found in the metal mining sector.

Benzene is not regulated in any metal mining jurisdiction worldwide.

Benzene was not considered further for effluent limits setting.

TOLUENE

Toluene was found in two mining effluents in Ontario. The average concentration of toluene found at one of the properties was 1.2 ug/litre (RMDL= .5 ug/litre). This property has almost exhausted its ore and will be closed in the near future. The average concentration of toluene found at the other property was 1.4 ug/litre. The source of the toluene at both properties could not be detemined. The most likely source would be an organic cleaner or de-greaser that contains toluene.

No specific practicable treatment technology for toluene in metal mining effluents could be found in the metal mining sector.

Toluene is not regulated in any metal mining jurisdiction worldwide.

Toluene was not considered further for effluent limits setting.

m-XYLENE; p-XYLENE; o-XYLENE

Xylene was found in only one mining effluent in Ontario. The average concentration of o-xylene was 4 ug/litre (RMDL= .5 ug/litre) and the average concentration of both m- and p-xylene was .2 ug/litre (RMDL= 1.1 ug/litre). This property has almost exhausted its ore and will be closed in the near future. The source of the xylene could not be determined but was likely due to an organic cleaner or de-greaser that contains xylene. The xylene could also be a component of specific mill chemicals in use.

No specific practicable treatment technology for xylene in metal mining effluents could be found in the metal mining sector.

Xylene is not regulated in any metal mining jurisdiction worldwide.

Xylene was not considered further for effluent limits setting.

2-METHYLNAPHTHALENE

2-methylnaphthalene was found in only one mining effluent in Ontario. The average concentration of the 2-methylnaphthalene was 3 ug/litre (RMDL= 2.2 ug/litre). This property has almost exhausted its ore and will be closed in the near future. The source of the 2-methylnaphthalene could not be determined.

No specific practicable treatment for 2-methylnaphthalene in metal mining effluents could be found in the metal mining sector.

2-methylnaphthalene is not regulated in any metal mining jurisdiction worldwide.

2-methylnaphthalene was not considered further for effluent limits setting.

NAPHTHALENE

Naphthalene was found in only one mining effluent in Ontario. The average concentration of the naphthalene was 2.6 ug/litre (RMDL= 1.6 ug/litre). This property has almost exhausted its ore and will be closed in the near future. The source of the naphthalene could not be determined.

No specific practicable treatment for naphthalene in metal

mining effluents could be found in the metal mining sector.

Naphthalene is not regulated in any metal mining jurisdiction worldwide.

Naphthalene was not considered further for effluent limits setting.

m-CRESOL; p-CRESOL

Cresol was found in only one mining effluent in Ontario. The average concentration of m-cresol was 30 ug/litre (RMDL= 3.4 ug/litre) and the average concentration of p-cresol was 30 ug/litre (RMDL= 3.5 ug/litre). Cresol is a component of a flotation chemical used at the property.

No specific practicable treatment for cresol in metal mining effluents could be found in the metal mining sector.

Cresol is not regulated in any mining jurisdiction worldwide.

Cresol was not considered further for effluent limits setting.

OIL AND GREASE

The parameter known as "oil and grease" was found in 68% of the metal mining effluents sampled.

The average concentration of "oil and grease" measured in the mining sector was 1.1 mg/litre (RMDL= 1 mg/litre). At many properties, however, occassional peaks averaging 13 mg/litre were recorded.

The sources of "oil and grease" in Ontario metal mines are well known. Some "oil and grease" may be of natural origin and result from the decay of vegetation on the property. However, the main sources of the "oil and grease" appear to be the oils and greases used on a routine basis at most mining operations in conjunction with mine/mill machinery and vehicles.

On a worldwide basis, "oil and grease" appears to be regulated only in Ontario (guidelines), British Columbia (guidelines) and in Tasmania (Australia). The common range of regulation is 10 to 15 mg/litre.

"Oil and grease" in the metal mining sector is largely found floating on the surface of effluents. Emulsions are not common.

Economic technology is available for the removal of floating oils and greases from metal mining effluents. Baffled sumps,

settling ponds and tailings ponds are in common use in the sector. Oil and grease is skimmed from sumps and other treatment devices when and where necessary. Recovered waste oil may be re-used on a mining property or it may be sent to a refiner of waste oils.

In the metal mining sector, there are substantial difficulties that involve the sampling and analysis of "oil and grease". With most "oil and grease" floating on the surface of effluents, it is very difficult to prove that any sample taken is actually representative of an effluent.

During the MISA effluent monitoring period for the metal mining sector, private laboratories contracted by the mining companies tended to use freon to recover "oil and grease" from sector effluents. The use of Freon is being phased out. Various environmental agencies are currently evaluating a number of different solvents for use in the test. Each solvent, including those currently in use, tends to extract "oil and grease" with an efficiency or at a rate that is peculiar to that particular solvent. As a consequence, "oil and grease" results for a specific effluent tend to differ depending on the type of solvent used. The metal mining Joint Technical Committee concluded that the sampling and analytical procedures currently available for "oil and grease" were controversial and were unlikely to consistently produce results that would accurately reflect the true nature of sector effluents.

"Oil and grease" was not considered further for effluent limits setting.

AMMONIA PLUS AMMONIUM

"Ammonia plus ammonium" were found in all (100%) of the metal mining effluents sampled.

The average concentration of "ammonia plus ammonium" measured in the metal mining sector was 1.4 mg/litre (RMDL=.25 mg/litre) in base metal mining effluents and 6.3 mg/litre in gold mining effluents. At the time of the MISA effluent monitoring program for the metal mining sector, there were two base metal mines and four gold mines with "ammonia plus ammonium" concentrations above 10 mg/litre.

In the metal mining sector, the use of ammonia for pH control or for metals precipitation has been largely discontinued. All metal mines normally use explosives. Explosives commonly in use all contain ammonium nitrate. The most common explosive in use in Ontario is ANFO which is 95% ammonium nitrate. Water gel explosives contain 60 to 80% ammonium nitrate and nitroglycerine-based explosives contain 40% ammonium nitrate. Minor amounts of explosives are spilled during use or do not take part in an explosion. Ammonium nitrate is highly soluble in water. The

geology, mining method and conditions in a mine determine the type of explosive that can be used in any particular circumstance. Safety is always a factor. Explosives containing smaller amounts of ammonium nitrate can sometimes be substituted for explosives containing higher amounts of ammonium nitrate. In many cases, however, substitution is simply not practicable or is not possible due to wet conditions underground.

In Canada, guidelines for ammonia in metal mining effluents exist in Ontario (10 mg/litre) and in British Columbia (1 mg/litre for new plants and 10 mg/litre for older plants). In the United States, ammonia is regulated only in the uranium sector at a level of 100 mg/litre. In Spain, ammonia is regulated between 15 and 50 mg/litre and in Tasmania, regulated levels of .5 mg/litre are stated.

Specific practicable demonstrated technology for the removal of the low levels of ammonia found in the high volume discharges that characterize the Ontario metal mining sector could not be found.

Ammonia was not considered further for effluent limits setting.

TOTAL KJELDAHL NITROGEN

"Total kjeldahl nitrogen" was found in 96% of the metal mining effluents sampled.

The average concentration of "total kjeldahl nitrogen" measured in the metal mining sector was 8 mg/litre (RMDL=.5 mg/litre).

"Total kjeldahl nitrogen" is not regulated in the metal mining sector worldwide.

Specific practicable demonstrated technology for the removal of "total kjeldahl nitrogen" from metal mining sector effluents could not be found.

"Total kjeldahl nitrogen" was not considered further for effluent limits setting.

NITRATE PLUS NITRITE

"Nitrate plus nitrite" was found in 90% of the metal mining effluents sampled.

The average concentration of "nitrate plus nitrite" measured in the metal mining sector was 8.8 mg/litre (RMDL=.25 mg/litre).

A guideline for "nitrate plus nitrite" exists in British

Columbia (10 mg/litre for new plants; 25 mg/litre for older plants). In Spain, nitrate itself is regulated within the range .5 to 1 mg/litre.

Specific practicable demonstrated technology for the removal of "nitrate plus nitrite" from metal mining sector effluents could not be found.

"Nitrate plus nitrite" was not considered further for effluent limits setting.

TOC: TOTAL ORGANIC CARBON

TOC is a measure of both particulate and dissolved "organic" carbon in an effluent. However, metal mining effluents frequently contain traces of carbon in the form of graphite. Graphite is found in varying amounts in and around many ore deposits. TOC also measures carbon from graphite.

TOC was found in 34% of the metal mining effluents sampled.

The average concentration of TOC measured in the metal mining sector was 8.4 mg/litre (RMDL=5 mg/litre).

TOC is not regulated in any metal mining jurisdiction in the world.

Specific practicable demonstrated treatment technology for TOC in metal mining effluents could not be found.

TOC was not considered further for effluent limits setting.

CHLORIDES

Chlorides were found in 80% of the metal mining effluents sampled.

The average concentration of chlorides measured in the metal mining sector was 83 mg/litre (RMDL=2 mg/litre).

In general, on a worldwide basis, chlorides are not regulated in the metal mining sector.

Specific practicable demonstrated technology for the removal of chlorides from metal mining effluents could not be found.

Chlorides were not considered further for effluent limits setting.

CYANATES (FILTERED)

Cyanates were found in 4% of the metal mining effluents sampled.

The average concentration of cyanates measured in the metal mining sector was 1.3 mg/litre (RMDL=5 mg/litre).

Cyanates, as measured in Ontario metal mining effluents, result from the incomplete oxidation of cyanides.

On a worldwide basis, cyanates are not regulated in the metal mining industry.

In 1990, the Ministry in association with Environment Canada produced a report entitled " Cyanate Toxicity, Treatment and Analysis". The report concluded that limited research has been conducted on cyanates and experimental data are scarce. The report stated that, while cyanate was found to be toxic to fish and mammals, the research data was variable and occasionally contradictory. The literature did appear to suggest that the LC50 for rainbow trout ranged from 15 to 81 mg cyanate/litre with results dependent on test conditions. The report also stated that cyanate appeared to be approximately 1000 times less toxic than cyanide (presumably to rainbow trout).

Demonstrated treatment technologies for the removal of cyanate from metal mining effluents are available. Alkaline chlorination is known to be effective in this area but, due to the use of chlorine as an integral part of the process and the possibility of the creation of chlorinated organics in the effluent being treated, alkaline chlorination is not recommended. Other common treatment processes that use ozone or hydrogen peroxide are thought to be capable of at least partial oxidation of cyanates in metal mining effluents.

Because of the limited occurrence of cyanates in Ontario metal mining effluents and because of the low levels of cyanate measured in these effluents, cyanates were not considered further for effluent limits setting.

DISSOLVED SOLIDS

Dissolved solids were found in all metal mining effluents sampled.

The average concentration of dissolved solids measured in the metal mining sector was 1,300 mg/litre (RMDL=20 mg/litre).

Newfoundland regulates (guidelines) dissolved solids in metal mining effluents at 1,000 mg/litre. British Columbia, using

guidelines, limits dissolved solids in metal mining effluents to 2,500 mg/litre (new mines) and to 5,000 mg/litre (older mines). Elsewhere, on a worldwide basis, dissolved solids are not regulated in metal mining effluents.

Demonstrated practicable technology for the removal of dissolved solids from metal mining effluents could not be found.

Dissolved solids were not considered further for effluent limits setting.

SULPHATES

Sulphates were found in 86% of the metal mining effluents sampled.

The average concentration of sulphates measured in the metal mining sector was 644 mg/litre (RMDL=5 mg/litre).

Sulphates are regulated within the range 1,200 to 1,600 mg/litre in metal mining effluents in Finland. Spain regulates sulphates in metal mining effluents at 2,000 mg/litre. Elsewhere, worldwide, sulphates in metal mining effluents are not regulated.

Practicable demonstrated technology for the removal of sulphates from metal mining effluents could not be found.

Sulphates were not considered further for effluent limits setting.

IRON

Iron was found in all metal mining effluents sampled.

The average concentration of iron measured in the metal mining sector was .45 mg/litre (RMDL=.02 mg/litre).

Many ore deposits contain large (percentage) amounts of iron. In the metal mining industry, ores frequently contain iron in combination with sulphur (iron sulphides). Many silicate minerals contain iron.

In the U.S., dissolved iron in effluents from iron, uranium and nickel mines is regulated within the range 1 to 2 mg/litre. In Finland, Italy and Spain, total iron is regulated within the general range 2 to 10 mg/litre. In Canada, total iron is limited ,in guideline form, in British Columbia to .3 mg/litre (new mines) and 1 mg/litre (older mines). In Quebec, the guideline limit for iron is 3 mg/litre.

Practicable demonstrated technology is available for the control of total and/or dissolved iron in metal mining effluents. In many cases, control of total and/or dissolved iron is achieved as a result of applied treatment for other metals in the effluent. In many cases, iron measured in metal mining effluents will be present as stable oxides or silicates. Soluble iron occurring in an effluent as the result of the formation of acid mine drainage can be controlled using standard acid drainage treatment techniques.

Because control of iron compounds in metal mining effluents is routinely achieved as a result of applied treatment for other substances in the effluents and because of the low levels of iron measured in the metal mining sector effluents, iron was not considered further for effluent limits setting.

THIOCYANATES (FILTERED)

Thiocyanates were found in 6% of the metal mining effluents sampled.

The average concentration of thiocyanates measured in the metal mining sector was 4 mg/litre (RMDL=5 mg/litre).

Thiocyanates are not regulated in any metal mining jurisdiction worldwide.

Practicable demonstrated technology for the removal of thiocyanates from metal mining effluents could not be found.

Because of the limited occurrence of thiocyanates in Ontario mining effluents and because average levels measured were below the RMDL for the substance, thiocyanates were not considered further for effluent limits setting.

URANIUM

Uranium was found in 22% of the metal mining effluents sampled.

The average concentration of uranium measured in the metal mining sector was .06 mg/litre (RMDL=.02 mg/litre).

Small amounts of uranium are found in most rock types. Uranium in Ontario metal mining sector effluents was only found in effluents from nuclear properties.

Uranium in Saskatchewan metal mining effluents is controlled within the range 2.5 to 5.0 mg/litre. Guidelines in British Columbia refer to UO2 and limit the substance to 2 mg/litre (new mines) and 5 mg/litre (older mines). Uranium in U.S. uranium mine

effluents is regulated within the range 2 to 4 mg/litre. Uranium does not appear to be limited in other metal mining jurisdictions worldwide.

The MISA program did not address radionuclides and the associated radioactivity in metal mining effluents.

Because of the low level of uranium measured in Ontario metal mining effluents and because of the lack of a mandate to regulate radioactive substances, uranium was not considered further for effluent limits setting.

The Final Candidate Parameter List

Based on the above review of the 42 parameters that remained after QA/QC assessment, a shorter list of parameters was developed for which effluent limits can be set. This list, referred to as the Final Candidate Parameter List, is presented below:

FINAL CANDIDATE PARAMETER LIST

total suspended solids
total cyanide
copper
nickel
lead
zinc
arsenic

The final candidate parameter list is augmented by requirements outlined in the Model Effluent Limits Regulation. Specifically, the metal mining sector effluent limits regulation will require that process effluent pH be maintained within the range 6.0 to 9.5 and that all process effluents be non-toxic to Rainbow Trout and Daphnia Magna.

THE DEVELOPMENT OF EFFLUENT LIMITS

Effluent limits for the metal mining sector are based on concentrations and are therefore independent of flow and production.

The metal mining sector consultant (Kilborn Inc./Environmental Applications Group Limited) after a worldwide search concluded that wastewater control technologies applied to the gold industry in Ontario are currently as sophisticated and varied as any applied throughout the world. In addition, the technologies currently being used by base metal mines in Ontario for pollution control are at least equivalent to, if not better than, those being used on an international basis.

Each ore deposit in Ontario is unique. As a consequence, each mine in Ontario is unique. A water pollution control technology in place at one mine may fail completely or perform poorly at another mine. Water pollution control technology in the metal mining sector must be applied on a site-specific basis. Generic treatment technologies that use substances such as lime, hydrogen peroxide and sulphur dioxide are widely applicable within the sector. The geology, mineralogy, geography, ground stability and mining and milling methods all combine to determine just how a particular generic technology will or can be applied at a specific mining property. Many mines are in remote locations. Transportation, labour and energy costs frequently impact the selection of treatment technologies.

The above factors are such that a single BAT plant or a limited number of BAT plants could not be selected to represent the metal mining industry or any significant portion of the industry. As a consequence, site performance data had to be developed for every plant in the metal mining sector.

In order to develop site performance data for every plant in the sector, the entire analytical database for the sector had to be carefully scrutinized to ensure that all data utilized accurately represented the nature of the effluents involved. The steps followed during the statistical data analysis are outlined in detail in the report entitled "The Metal Mining Sector Effluent Monitoring Data; For the Period February 1,1990 to January 31, 1991". Additional data concerning the specific number of data points involved with various remark codes and the relative percentage of each are found in Appendix 11 of this report.

The key steps followed during the statistical data analysis were:

- data editing of "less than detection level" results
- estimation of LTA (long term average) concentrations
- statistical outliers analysis
- variability analysis
- setting of performance values

Data Editing

This topic is fully covered in the sector monitoring database report. "Less than detection level (<DL)" data were treated in the following way:

- if the result which was reported was less than the Laboratory Method Detection Limit (LMDL) and greater than 1/10 RMDL, the value was kept as reported

- if the result that was reported was less than 1/10 RMDL, the value was replaced by 1/10 RMDL

Estimation of LTA (Long Term Average) Concentrations

A good estimate of LTA concentrations is necessary to set compliance limits. When a large number of observations are available, LTA provides a representative database encompassing all sources of variability. An LTA based on such data can be assumed to be an unbiased estimate of the population mean.

An LTA concentration value for each parameter on the Final Candidate Parameter List (see above) (including pH) was calculated for each plant (waste stream) in the metal mining sector as an arithmetic average of all of the valid data collected during the MISA monitoring period. Ultimately, the LTA concentration values for each parameter for every plant in the sector were averaged to calculate LTA concentrations for the sector. Variability factors were handled in the same way.

Statistical Outliers Analysis

In order to assess whether the LTA concentrations and variability factors are representative of operating conditions, analysis of extreme values (outliers) was carried out. Outlier values may be a result of plant upsets, extreme weather conditions, QA/QC problems, sampling errors or may be due to unknown causes. Outliers may be non-representative of normal plant operating conditions or may be indicative of other environmental problems requiring investigation.

All of the data (including outliers) in the final metal mining sector database was used in the limits setting process. Where appropriate, limits were calculated on the basis of "all data" and "outliers excluded" for purposes of comparison.

Concentration Variability Factors

In order to set a limit which is achievable by sector plants, some allowance for variability has to be included. Sources of variability include analytical and sampling uncertainty, process variations, variability of treatment plant operations and influences of extreme weather conditions.

The IRC process (see: MISA Issue Resolution Process; Issue Resolution Report; Toronto; June 1990) established two variability factors: one for setting the maximum daily performance value (the daily variability factor- VF1) and another for setting the monthly average performance value (the monthly variability factor- VF4 or VF30). The daily maximum and monthly average variability factors are calculated from the fitted probability distribution as the ratio of the 99th percentile and 95th percentile, respectively, to the expected mean.

The site performance data which includes the results of all calculations of LTA, VF1, VF4, DAYLIM and M4LIM for each plant (waste stream) in the metal mining sector are presented in Appendix 12 of this report. In Appendix 12, "Ctrlpt." means "control point" and "N" means the number of samples (or observations) in the data set.

In general, VF1 gives rise to a daily limit based on the data that is available. VF4 gives rise to a monthly limit based on weekly sampling (or 4 samples per month).

Setting of Performance Values

An LTA concentration based on BAT performance sets a standard of performance to be expected from plants in compliance on a "long term" basis such as one year. Since no individual BAT plants could be identified in the metal mining sector as being representative of all plants in the sector or as being representative of a group of plants within the metal mining sector, performance values finally chosen for the individual parameters on the Final Candidate Parameters List were based on the average of the performance values (DAYLIM and M4LIM) for all plants in the sector.

The performance values calculated for the individual parameters on the Final Candidate Parameters List were as follows:

pH:

M4LIM	(all data)	8.7
DAYLIM	(all data)	9.7

suspended solids (mg/litre):

M4LIM	(all data)	25
DAYLIM	(all data)	57

copper (mg/litre):

M4LIM	(all data)	.22
DAYLIM	(all data)	.61

lead (mg/litre)

M4LIM	(all data minus 2)	.03
DAYLIM	(all data minus 2)	.07

Note: data not considered:
M4LIM : Cameco Blind River 57
Canamax Bell Creek 14
DAYLIM : Cameco Blind River 126
Canamax Bell Creek 32

nickel (mg/litre):

M4LIM	(all data)	.67
M4LIM	(all data minus 2)	.31
DAYLIM	(all data)	1.9
DAYLIM	(all data minus 2)	.77

Note: data not considered:

M4LIM	: Inco Nolin Creek	7.9
	Inco Whistle Mine	7.3
DAYLIM	: Inco Nolin Creek	25
	Inco Whistle Mine	24

zinc (mg/litre):

M4LIM	(all data)	.28
DAYLIM	(all data)	.73

arsenic (mg/litre):

M4LIM	(all data)	.08
DAYLIM	(all data)	.17

total cyanide (mg/litre as N):

M4LIM	(all data)	.99
M4LIM	(all data minus 1)	.58
DAYLIM	(all data)	3.4
DAYLIM	(all data minus 1)	1.8

Note: data not considered:

M4LIM	: Renabie Mines	10.5
DAYLIM	: Renabie Mines	35.5

In all cases above, "data not considered" means the data that were not considered in arriving at the "all data minus ?" value.

The Ratio DAYLIM /M4LIM

In metal mining jurisdictions, in Canada, the United States and elsewhere, there is routinely a common relationship between the least and most stringent value allowed for a regulated parameter. This relationship is a factor of 2. Why this relationship is so consistent on a worldwide basis in metal mining jurisdictions could not be determined. How the factor evolved could not be determined.

The relationship between the DAYLIM and the M4LIM values for all parameters on the Final Candidate Parameters list was investigated. The ratio DAYLIM /M4LIM for each parameter was determined as follows:

pH	1.1
suspended solids	2.3
copper	2.8
lead	2.0
nickel	2.4
zinc	2.6
arsenic	2.1
total cyanide	3.2

The arithmetic average of the above ratios is 2.3 .

Based on the above and with the knowledge that most metal mining jusrisdictions in the world maintain a factor of 2 between the most stringent and least stringent values for most regulated parameters, a factor of two was also applied to the Ontario metal mining effluent limits regulation to simplify the relationship between the least and most stringent values given for each parameter.

Final Performance Limits Suggested By The MISA Database

Based on all of the above and ignoring the intention to impose a factor of two between the least and most stringent requirements for parameters, the following are the M4LIM and DAYLIM suggested for each parameter by the MISA database:

	M4LIM	DAYLIM
pH	8.7	9.7
suspended solids	25	57
copper	.22	.61
lead	.03	.07
nickel	.31 to .67	.77 to 1.9
zinc	.28	.73
arsenic	.08	.17
total cyanide (as N)	.58 to .99	1.8 to 3.4

THE ONTARIO EFFLUENT LIMITS

Extreme caution must be exercised in the interpretation of the MISA database for the metal mining sector. The MISA database itself is of very high quality and is perhaps one of the best databases describing metal mining effluent quality currently existing

worldwide. Nevertheless, the database does present substantial difficulties in interpretation and these must be noted. Of prime importance is the fact that the database deals solely with effluent quality. Influent quality data do not form part of the database. The terms of the MISA program in the metal mining sector were such that, because of the unique nature of each mine, all effluents from all significant mining properties had to be sampled. The cost of the program, largely borne by industry, was between 13 and 18 million dollars (Canadian). Influent sampling would have approximately doubled the cost of the program and this was not feasible. As a consequence, although the database describes effluent quality at a specific property in great detail, the quality of the influent is not known. As a result, the efficiency of any treatment technology or technology train operating at a specific property cannot be determined by using the database. While it is logical, for example, to assume that copper is in the influent to a treatment plant operating at a copper mine, copper also commonly occurs, sometimes in low concentrations, in the effluents from many other properties including gold mines. Therefore, it is not particularly obvious at any property whether a particular parameter is in a final effluent at a low level because of the efficiency of a treatment device or because the parameter was simply at a low level in the influent to the device to begin with and the device had little or no effect on the parameter. The best professional judgement of the metal mining Joint Technical Committee and the associated working groups was essential in the final determination of the effluent limits for the Ontario metal mining sector. Another difficulty encountered with the interpretation of the database is that some of the technologies installed and operating in the Ontario industry which are regarded as best available technology (economically achievable) were being operated to achieve compliance with existing guidelines. The effluent quality data available from these existing treatment facilities may or may not represent the capability of these plants. In addition, some of the technologies that were capable of achieving specified parameter levels in a laboratory or pilot environment did not appear to do as well in every field situation. One final difficulty with the metal mining sector database is that the database represents the effluent quality from the Ontario metal mining industry as it existed for the 12-month period February 1, 1990 to January 31, 1991. Several of the properties listed in the database have since ceased operations due to factors which include economic considerations and exhaustion of ore reserves. New properties have opened. The database, therefore, represents the general nature of metal mining sector effluents in Ontario.

pH

The database current performance effluent limits are as follows:

M4LIM 8.7 DAYLIM 9.7

The MISA Model Effluent Limits Regulation requires that the pH of process effluents be maintained within the range 6.0 to 9.5 at all times. Technology is available to control the pH of metal mining sector effluents within this range. The technology is widely demonstrated and is generally regarded as economical. During the MISA effluent monitoring period, existing Ministry mineral industry guidelines required sector effluents to be within the pH range 5.5 to 10.6 .

The Metal Mining Sector Effluent Limits Regulation requires that the pH of process effluents be maintained within the range 6.0 to 9.5

Suspended Solids

The database current performance effluent limits are as follows:

M4LIM 25 mg/litre DAYLIM 57 mg/litre

The average concentration of suspended solids measured in Ontario metal mining effluents was 7 mg/litre. Occasional peaks above 50 mg/litre were noted at many properties. Peaks were generally associated with storm events including heavy precipitation and high winds or with management practices. Many solids settling facilities in the industry collect runoff from areas upstream of the settling facilities. During and after storm events, the hydraulic loading on some of the areas is such that settling efficiencies drop.

Economic technology for the removal of suspended solids from metal mining sector effluents is widely demonstrated. In Ontario, suspended solids in metal mining effluents have been regulated at 15 mg/litre for at least 26 years.

In order to ensure that a less stringent regulation for suspended solids was not put in place as a result of the MISA program, 15 mg/litre was chosen as the most stringent level for suspended solids in process effluents. A factor of 2 was used to derive the less stringent requirement.

The limits for suspended solids in Ontario metal mining process effluents are as follows:

M4LIM 15 mg/litre DAYLIM 30 mg/litre

Metals

The database current performance effluent limits are as follows:

	M4LIM (mg/litre)	DAYLIM (mg/litre)
copper	.2	.6
nickel	.5	1.3
lead	.03	.07
zinc	.3	.7

The current performance effluent limits for lead are low due to the fact that lead tends to remain in waste retention areas. The most common ore mineral of lead, in Ontario, is galena (a lead sulphide). Galena is very heavy and particles of the mineral tend to settle quickly. Even the most soluble lead salts tend to be only sparingly soluble in cold water. Lead, along with copper and/or zinc, is mined at several Ontario properties. While lead does not routinely occur in metal mining sector effluents in high concentrations, the toxicity of lead combined with the fact that quanities of lead are contained in many Ontario metal mining waste retention areas suggests a need for regulation. In fact, lead is regulated in metal mining jurisdictions worldwide.

Technology for the removal of metals from metal mining effluents has been demonstrated on a worldwide basis. In Canada, base metal mines are regulated by Environment Canada (federal government). The most stringent levels stated for copper, nickel, lead and zinc in the federal regulations are as follows:

lead	.2 mg/litre
copper	.3 mg/litre
nickel	.5 mg/litre
zinc	.5 mg/litre

The levels are stated as a "maximum authorized monthly arithmetic mean concentration". In the same regulations, the "maximum authorized concentration in a grab sample" is double the above values.

The similarities between the existing federal requirements for the metals being discussed and the MISA database suggested effluent limits helped the Joint Technical Committee and the associated working groups to conclude that the adoption of the most stringent aspects of the federal regulation for the Ontario metal mining effluent limits regulation would be appropriate. A factor of 2 was applied to derive the less stringent requirements. The federal requirements do not apply to gold mines. The Joint Technical Committee and associated working groups concluded that sufficient demonstrated technology was available worldwide to extend the federal requirements for copper, nickel, lead and zinc to gold mines in the Ontario regulation.

The limits for metals in Ontario metal mining process effluents are as follows:

	M4LIM (mg/litre)	DAYLIM (mg/litre)
lead	.2	.4
copper	.3	.6
nickel	.5	1.0
zinc	.5	1.0

Total Cyanide

The database current performance effluent limits are as follows:

M4LIM .8 (mg/litre) DAYLIM 2.6 mg/litre

A number of demonstrated treatment technologies are available for the control of cyanide in metal mining effluents. Up to the present time in Ontario, total cyanide in metal mining effluents has been regulated (in the form of a guideline) at a level of 2 mg/litre. Current technologies are capable of achieving 1 mg/litre total cyanide in metal mining effluents.

The limits for total cyanide in Ontario metal mining process effluents are as follows:

M4LIM 1 mg/litre DAYLIM 2 mg/litre

Arsenic

The database current performance effluent limits are as follows:

M4LIM .1 mg/litre DAYLIM .2 mg/litre

Demonstrated treatment technologies for the control of arsenic in metal mining sector effluents are limited. These technologies on a site-specific basis are occasionally capable of reaching levels of .1 mg/litre. With care, levels of .5 mg/litre can be routinely achieved. Up to the present time in Ontario, arsenic in metal mining sector effluents has been regulated (in the form of a guideline) at a level of .5 mg/litre.

The limits for arsenic in Ontario metal mining process effluents are as follows:

M4LIM .5 mg/litre DAYLIM 1 mg/litre

Overall Implications Of MISA Effluent Limits For Ontario Metal Mines

Although most Ontario metal mines have been identified as having BAT in place, improvements can be made in the operation of many of the wastewater treatment systems. Steps can be taken to maintain low parameter concentrations in final effluents and to moderate daily and monthly concentration fluctuations. In general, the impact of the MISA effluent limits on the Ontario metal mining industry will be highly site-specific.

It is important to note that the MISA effluent limits for Ontario metal mines only apply to copper, nickel, lead, zinc, gold, silver, iron and uranium mines. The effluent limits apply only to metal mining operations that produce copper, nickel, lead, zinc, gold, silver, iron or uranium or any combination of these metals as a principal product. A metal mine producing any other metal (example: molybdenum) than those mentioned above is exempt from the regulation. The regulation can, however, be amended at any time to include other parameters (including metals) of concern. Substantial justification is normally required before a regulation of this nature can be amended.

The MISA effluent limits for Ontario metal mines apply only to "operating metal mines". As defined in the regulation, an operating metal mine means a mine that is in commercial production of a metal or a combination of metals, or a metal-bearing substance or a combination of metal-bearing substances for either immediate sale or stockpiling for ultimate sale.

Abandoned mines are under the jurisdiction of the Ministry of Northern Development and Mines and are not covered by the MISA metal mining sector effluent limits regulation.

Nuclear facilities (uranium mines and refineries) in Ontario are under federal jurisdiction. The MISA metal mining sector effluent limits regulation is intended to apply to Ontario uranium mines and refineries since these facilities do operate within the boundaries of the Province of Ontario and wastewaters from these facilities are discharged to Ontario receiving waters. At the Joint Technical Committee, the Atomic Energy Control Board indicated an intent, when and where possible, to include the MISA limits for Ontario metal mines into the licences for uranium mines and refineries that are located in Ontario. The Atomic Energy Control Board does reserve the right to make any changes to the MISA limits as they apply to Ontario uranium mines and refineries in Board licences.

The MISA effluent limits regulation for the Ontario metal mining sector applies to all existing and new operating metal mines.

The MISA effluent limits regulation for the Ontario metal mining sector applies only with respect to existing and new metal mines that discharge a daily plant volume greater than fifty cubic meters per day. Daily plant volume is defined in the regulation and is intended to mean the aggregate volume of all minewater effluents, smelter-refinery effluents, cooling water effluents, emergency overflow effluents and process effluents (which include tailings area discharges). Fifty cubic meters per day is approximately eleven thousand gallons per day.
Note: The Ministry of the Environment does not require a Permit to Take Water for volumes less than fifty thousand litres (fifty cubic meters) per day.

Because of the definition of "operating metal mine", the definition of "metal" and the exemption of mines that discharge fifty cubic meters or less of wastewater per day, metal mining activities that are usually referred to as "exploration and development" including "advanced exploration" are exempt from the MISA metal mining effluent limits regulation. For the purposes of the regulation, mining for a bulk sample does not constitute "stockpiling for ultimate sale" even though all or part of a bulk sample may eventually be sold.

A direct discharger that, for any period of time, does not discharge an effluent is exempt, for that period, from the requirements of the regulation that pertain to that effluent.

The limits stated in the metal mining sector effluent limits regulation are more stringent than the limits stated in the existing Ministry guidelines for mining effluents. Concentration compliance limits are reduced by 50% for cyanide, 70% for copper, 80% for lead, 50% for nickel and 50% for zinc. Compliance limits for suspended solids (currently the most stringent in the world) and for arsenic (due to a lack of technology) will remain the same but in regulation rather than guideline form.

All process effluents in the metal mining sector, undiluted, are required to be non-toxic to rainbow trout and Daphnia magna.

Compared to existing Ministry guidelines for mining effluents, the regulation will narrow the required pH range from 5.5 - 10.6 to 6.0 - 9.5 .

Many Ontario metal mining sector companies have already installed the best available technology as defined within the MISA program.

The limits stated in the metal mining sector effluent limits regulation can be achieved using existing demonstrated technologies.

Substantial loadings reductions on an industry-wide basis are expected as a result of the application of the metal mining sector effluent limits regulation. Expected loadings reductions are given

in detail in Appendix 13 of this document. The loadings reductions given in Appendix 13 are based on the MISA 12-month monitoring period for the metal mines in Ontario. Some mines that operated during the MISA monitoring period are now closed. Some mines that were not operating during the MISA monitoring period are now operating. The data contained in Appendix 13 serves as a general estimate of the loadings reductions that can be expected as a result of the application of the metal mining sector effluent limits regulation in Ontario.

The Limits Regulation

Chapter Six

of the

Development Document

THE EFFLUENT LIMITS REGULATION

The Effluent Limits Regulation for the Metal Mining Sector establishes the terms and conditions of compliance. The Regulation consists of a number of sections which cover definitions, compliance, record keeping, reporting and timing.

SECTIONS OF THE REGULATION

Interpretation (Definitions)

The Regulation provides definitions of terms used in the Regulation in order to clarify the meaning of those terms which may have different interpretations and to explain technical terms which may not be in common usage.

Purpose

The purpose of the Effluent Limits Regulation is to monitor and control the quality of effluent discharged from operating plants in the Metal Mining Sector. This is done by limiting the concentrations of specified substances that commonly occur in Metal Mining Sector process effluents and by requiring that process effluents in the sector be non-acutely lethal to the aquatic species specified in the Regulation.

The Regulation requires the monitoring of cooling water effluent streams and emergency overflow effluent streams in order to ensure that these streams are not contaminated.

Application

The Regulation applies only with respect to existing or new operating metal mines in the Province of Ontario that discharge a total combined volume of process effluent, cooling water effluent and/or emergency overflow effluent of more than fifty cubic meters per day.

The Regulation applies only to operating mines that are producing copper, nickel, lead, zinc, gold, silver, iron or uranium or any combination of these.

By-Passes

The Regulation prohibits by-passes. All process effluents must be discharged through sampling points that have been designated.

Sampling and Analytical Procedures

In order to ensure accurate sampling and analysis of effluents, standard sampling and analytical procedures have been developed by the Ministry. The Ministry protocol on sampling amd analysis

entitled "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater": Ontario Ministry of Environment and Energy, dated July, 1993, outlines how a discharger must collect a sample, how the sample should be analyzed and the minimum analytical method detection level that the laboratory must meet when analyzing the sample.

Each discharger must ensure that all sampling equipment is maintained properly in order to ensure that a representative sample is always collected.

Sampling Points

A discharger must designate sampling points on all process effluent streams, cooling water effluent streams and emergency overflow effluent streams. The sampling point locations must be representative of the effluent. All samples collected for the Regulation must be taken from designated sampling points.

Calculation of Concentrations, Loadings and Retention Times

All stated numerical compliance limits in the Regulation are based on concentrations. Concentrations, as measured, are independent of flow and industrial production. As a consequence, the numerical limits given in the Regulation are not impacted by flow measurement accuracy and there is no need to report levels of industrial production or to adjust the limits based on changing levels of industrial production.

In order to determine compliance with the monthly average concentration limit, a monthly average concentration must be calculated for each limited parameter. A monthly average concentration is calculated by taking the arithmetic mean of the daily concentrations of the samples that are required by the Regulation throughout the month.

Loadings are not limited within the Regulation. However, loadings must be calculated and reported for all process effluents, cooling water effluents and emergency overflow effluents.

The following rules must be observed when calculating parameter loadings:

- The actual analytical result obtained by the laboratory should be used by the discharger

- If the actual analytical result is less than one-tenth of the analytical method detection limit set out in the Ministry of Environment and Energy publication entitled "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater" dated July, 1993, the discharger should use the value zero for the purpose of performing calculations.

A daily effluent stream loading, in kilograms, is calculated by

multiplying, with necessary adjustment of units, the analytical result obtained from the sample for a parameter by the measured daily volume of effluent at the sampling point.

A daily effluent plant loading for a parameter for a day is the sum, in kilograms, of all daily effluent stream loadings of a specific type.

A monthly average effluent plant loading for a parameter for a month is the arithmetic mean of the daily effluent plant loadings for the parameter.

The Regulation allows the collection of a single grab sample of process effluent instead of a composite sample if the calculated retention time of the process effluent is 30 days or more. In addition, if the process effluent is minewater effluent or smelter-refinery effluent, a single grab sample, instead of a composite sample, may be taken if the calculated retention time is 5 days or more.

Retention times are calculated, in days, by dividing the total available volume of a waste treatment facility by the average daily volume of effluent from the facility with suitable adjustment in units to yield a result in days.

Parameter and Lethality Limits

Daily Concentration Limits

A plant must not exceed the daily concentration limits listed in Column 3 of Schedule 2 on any operating day.

Monthly Average Concentration Limits

A plant must not exceed the monthly average concentration limits listed in Column 4 of Schedule 2 during any month of the year.

In the Regulation, daily concentration limits and monthly average concentration limits are given for copper, nickel, lead, zinc, arsenic, total suspended solids and total cyanide.

pH

The Regulation states that a plant must not discharge a process effluent that has a pH below 6.0 or above 9.5 at any time.

Acute Lethality

A plant must not discharge a process effluent or a cooling water effluent that is acutely lethal to rainbow trout or Daphnia magna. An acutely lethal effluent is one that kills fifty percent of the test species in undiluted (one hundred percent) effluent. Rainbow trout are exposed to undiluted effluent for 96 hours during the test; Daphnia magna are exposed to undiluted effluent for 48 hours

during the test.

Monitoring

The frequency of monitoring for each parameter in a process effluent is given in Column 2 of Schedule 2 of the Regulation. Total suspended solids and total cyanide (for operating gold mines only) are monitored on a daily basis. All other parameters (and total cyanide for all other operating plants) are monitored on a weekly basis.

pH is monitored daily at all operating plants (process effluents only).

Cooling water effluents are monitored for total suspended solids on a weekly basis.

Emergency overflow effluents are monitored daily for total cyanide, total suspended solids, copper, nickel, lead, zinc and arsenic. Emergency overflow effluents, in the Metal Mining Sector, should occur infrequently (once every ten, twenty, thirty or forty years) and are only monitored when they occur.

Process effluent quality control samples are collected from a single process effluent stream at each plant once per year and are analyzed for all parameters listed in Schedule 2.

Monthly acute lethality tests using rainbow trout and Daphnia magna are required for all process effluents and all cooling water effluents. Monitoring is reduced to quarterly for a species when twelve consecutive tests have been passed.

When twelve consecutive rainbow trout acute lethality tests and twelve consecutive Daphnia magna acute lethality tests have been passed at a plant, chronic toxicity testing using fathead minnows and Ceriodaphnia Dubia is required at a frequency of once every six months.

Effluent Volume

A discharger must calculate the daily volume of process effluent that is discharged from each process effluent stream on each day that process effluent is discharged. The daily volume of cooling water effluent and emergency overflow effluent must also be determined (cooling water effluent: once per week; emergency overflow effluent: on a daily basis when such an effluent occurs).

Process effluent flows must be measured to an accuracy of plus or minus fifteen percent. Cooling water effluent flows and emergency overflow effluent flows must be measured to an accuracy of plus or minus twenty percent.

All flow measurement devices must be installed properly, be properly maintained and be easily accessible for inspection.

Flow is recorded in cubic meters (example: cubic meters per day).

Storm Water Control Study

Each discharger must complete a storm water control study within two years, after the Regulation comes into force, according to the Ministry of Environment and Energy publication entitled "Protocol For Conducting A Storm Water Control Study (August, 1993)". A discharger may be exempted from a storm water control study if the discharger qualifies for exemption as specified in the protocol.

If a discharger plans to make process changes, install waste treatment facilities, implement management practices or make other changes that will affect the quality and quantity of storm water discharged from the plant and notifies the Ministry in writing, additional time will be provided for the completion of the storm water control study.

Records and Reports

Each discharger should make each record required by the Regulation as soon as reasonably possible. All records are to be kept for at least three years and should be accessible to the Ministry for inspection. Records are normally required to be in an electronic format. In some cases, hard copies of the electronic records are also required.

Records should be made of the following:

- all analytical results obtained under monitoring and all calculations performed

- all sampling and analytical procedures used including, for each sample, the date, the time of pick-up and any incidents likely to affect the analytical results

- the results of all quality control monitoring, acute lethality and chronic toxicity testing

- all records of flow measurement as well as records of maintenance and calibration of flow measuring devices

- all problems of malfunction related to sampling, chemical analysis, acute lethality and chronic toxicity testing and flow measuring devices detailing the date and duration of any malfunction and the remedial action taken

- any by-passes stating the date, duration, cause and nature of each by-pass

- all process changes and redirections of or changes in the character of effluent streams that affect the quality of effluent at any sampling point

- the location of each sampling point established at the discharger's plant

Reports Available to the Public

Each discharger is required to prepare an annual summary of all test results and calculations (concentrations, loadings, flow and toxicity) and all non-compliance events, on or before the first day of June of each year and make the summary available to the public during the plant's normal office hours.

Reports to the Director

Each discharger is required to notify the Director in writing of:

- any change of name or ownership occurring after the day the Regulation comes into force, within thirty days after the end of the month in which the change occurs

- any process change or redirection of or change in the character of an effluent stream that affects the quality of effluent at any sampling point within thirty days of the change or redirection

- any non-compliance event (concentration limit, pH, lethality, by-pass)

Quarterly Reports to the Director

Each discharger is required to submit a quarterly report to the Director in an electronic format and in hard copy no later than forty-five days after the end of each quarter. The report should include:

- the monthly average plant loadings, the highest and lowest daily plant loadings and the monthly average concentration and the highest and lowest daily concentration for the month for each limited parameter and each assessment parameter

- the monthly average process effluent plant volume and the highest and lowest daily process effluent plant volume

- the monthly average cooling water effluent plant volume and the highest and lowest daily cooling water effluent plant volume

- the daily emergency overflow effluent loading and concentrations for each day that an emergency overflow occurs

- the highest and lowest pH results obtained for each month in the quarter for each process effluent monitoring stream

- the number of days and dates in each month in the quarter on which process effluent, cooling water effluent and emergency

overflow effluent was discharged from the discharger's plant

Reports to the Director on Chronic Toxicity Testing

A discharger is required to report the results of all chronic toxicity testing within sixty days after the semi-annual period for which the samples were collected.

Commencement and Revocation Provisions

Ontario Regulation 359/88 is revoked ninety days after the day on which this Regulation is filed.

Parameter and lethality limits come into force on ...., 199.. Parts V and VI come into force on the date that is ninety days after the day on which this Regulation is filed.

ADDITIONAL NOTES ON THE APPLICATION OF THE REGULATION

The Regulation applies only to existing and new operating plants in the Province of Ontario that produce copper, nickel, lead, zinc, gold, silver, iron or uranium or any combination thereof. Plants producing any other metal as a principal product are not covered by the Regulation. The Regulation can be amended to include other metals if sufficient justification can be demonstrated.

The Regulation applies only to operating plants. Definitions are given in the Regulation for "plant", "mine", "operating metal mine" and "metal". Because of these definitions and the exemption of plants that discharge less than 50 cubic meters of wastewater per day, metal mining activities that are usually referred to as "exploration and development" including "advanced exploration" are exempt from the Regulation. For the purposes of the Regulation, mining for a bulk sample does not constitute "stockpiling for ultimate sale" even though all or part of a bulk sample may eventually be sold.

"Idle" plants, plants on "stand-by", plants that are "inactive" or "abandoned" that are not actively producing a metal or metals specified in the Regulation are exempt from the Regulation. As an example, a mine on "stand-by" that is not actively producing a metal or metals specified in the Regulation but is pumping minewater is exempt from the Regulation.

Many operating metal mines in Ontario hold wastes for varying lengths of time. That is, actual discharges of wastewater are intermittent. The Regulation states that, on any day that an effluent is not discharged, that effluent, for the period of time of none-discharge, is exempt from the requirements of the Regulation that apply to that effluent.

Under the Regulation, all Ontario gold mines are required to monitor "total cyanide" on a daily basis. All other Ontario mines (plants) are required to monitor "total cyanide" on a weekly basis.

In spite of the foregoing, plants that do not use cyanide as a process chemical are not required to monitor "total cyanide". In addition, plants (including gold mines) are not required to monitor "total cyanide" in minewater effluents.

The Effluent Limits Regulation

Appendix 1

of the

Development Document

ONTARIO REGULATION ??/??

UNDER THE ENVIRONMENTAL PROTECTION ACT

DRAFT EFFLUENT LIMITS REGULATION

FOR THE

METAL MINING SECTOR

MINISTRY OF ENVIRONMENT AND ENERGY
SEPTEMBER, 1993

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REGULATION MADE UNDER THE ENVIRONMENTAL PROTECTION ACT

EFFLUENT MONITORING AND EFFLUENT LIMITS - METAL MINING SECTOR

PART 1-GENERAL

Interpretation

1.-(1) In this Regulation,

"assessment parameter" means a parameter that is listed in Schedule 3 or 4;

"blowdown water" means recirculating water that is discharged from a cooling water system for the purpose of controlling the level of water in the cooling water system or for the purpose of discharging from the cooling water system materials contained in the cooling water system the further build-up of which would impair the operation of the system;

"cooling water effluent" means water and associated material that is used in an industrial process for the purpose of removing heat and that has not, by design, come into contact with process materials, but does not include blowdown water;

"cooling water effluent monitoring stream" means a cooling water effluent stream on which a sampling point is established under section 8;

"cooling water effluent sampling point" means a sampling point established on a cooling water effluent stream under section 8;

"discharger" means an owner or person in occupation or having the charge, management or control of a plant to which this Regulation applies;

"Director", in relation to obligations of a discharger, means a Director appointed under section 5 of the Act and responsible for the region in which the discharger's plant is located and includes an alternate named by the Director;

"emergency overflow effluent" means an effluent discharged through an engineered structure that has been designed to protect waste disposal facilities from catastrophic failure, and is not considered to be a process effluent;

"emergency overflow effluent monitoring stream" means an emergency overflow effluent stream on which a sampling point is established under section 8;

"emergency overflow effluent sampling point" means a sampling point established on an emergency overflow effluent stream under section 8;

"limited parameter", in relation to a plant, means a parameter for which a limit is specified for the plant in column 3 or 4 of Schedule 2;

"metal" means copper, nickel, lead, zinc, gold, silver, iron or uranium, or any combination thereof;

"mine" means any opening or excavation in, or working of the ground, for the purpose of winning any metal, mineral or mineral-bearing substance, and all ways, works, machinery, plant, buildings and premises below or above the ground belonging to or used in connection with such activity, and any roasting or smelting furnace, concentrator, mill, work or place used for or in connection with washing, crushing, grinding, sifting, reducing, leaching, roasting, smelting, refining, or treating of such substances;

"minewater effluent" means effluent from a mine, pit or quarry;

"operating metal mine" means a mine that is producing a metal or a combination of metals, or a metal-bearing substance or a combination of metal-bearing substances for either immediate sale or stockpiling for ultimate sale;

"pick-up", in relation to a sample, means pick-up for the purpose of transportation to and analysis at a laboratory;

"plant" means an operating metal mine and the developed property, waste disposal sites and wastewater treatment facilities associated with it;

"process change" means a change in equipment, production processes, process materials or treatment processes;

"process effluent" means,

(a) effluent that, by design, has come into contact with process materials,

(b) blowdown water,

(c) effluent that results from cleaning or maintenance operations at a plant during a period when all or part of the plant is shut down, and

(d) minewater effluent

(e) smelter-refinery effluent

(f) any effluent described in clauses (a) to (e) combined with cooling water effluent or storm water effluent;

"process effluent monitoring stream" means a process effluent stream on which a sampling point is established under section 8;

"process effluent sampling point" means a sampling point established on a process effluent stream under section 8;

"process materials", in relation to a discharger's plant, means raw materials for use in an industrial process at the plant, manufacturing intermediates produced at the plant, or products or by-products of an industrial process at the plant, but does not include chemicals added to cooling water for the purpose of controlling organisms, fouling and corrosion;

"quarter" means all or part of a period of three consecutive months beginning on the first day of January, April, July or October;

"smelter-refinery effluent" means effluent from a smelter, a refinery or both;

"semi-annual period" means all or part of a period of six months beginning on the first day of January or July;

"storm water effluent" means run-off from a storm event or thaw that is not used in any industrial process;

"waste disposal site" means a waste disposal site other than those used for the storage of waste materials from nuclear refineries or nuclear power plants

2) This Regulation applies both to effluent streams that discharge continuously and to effluent streams that discharge intermittently.

(3) An obligation on a discharger to do a thing under this Regulation is discharged if another person has done it on the discharger's behalf.

(4) A discharger that, on any day, does not discharge a process effluent, a cooling water effluent or an emergency overflow effluent, is exempt for that day, from the requirements of this Regulation that pertain to that effluent.

(5) A discharger need not collect any sample required to be collected by this Regulation if to do so would result in extraordinary danger to health or safety.

Purpose

2. The purpose of this Regulation is to monitor and control the quality of effluent discharged from the plants listed in Schedule 1.

Application

3.-(1) This Regulation applies only with respect to the plants listed in Schedule 1.

(2) This Regulation applies only with respect to existing or new plants that discharge a combined total volume of process effluent, cooling water effluent and emergency overflow effluent of more than fifty cubic metres per day.

(3) This Regulation does not apply with respect to the discharge of effluent to a municipal sewer.

Obligations Under Approvals, Orders, etc.

4. Nothing in this Regulation shall be interpreted to limit or reduce a discharger's obligations under an approval, order, direction or other instrument issued under any Act.

Non-application of General Effluent Monitoring Regulation

5. This Regulation is not a Sectoral Effluent Monitoring Regulation within the meaning of Ontario Regulation 695/88.

By-passes

6. Beginning on January 1, 1996, a discharger shall not permit process effluent to be discharged from the discharger's plant unless the process effluent flows past a sampling point established on a process effluent stream in accordance with this Regulation before being discharged.

Sampling and Analytical Procedures

7.-(1) Each discharger shall carry out the establishment of sampling point obligations of this Regulation and the sampling and analysis obligations of this Regulation, including quality control sampling and analysis obligations, in accordance with the procedures described in the Ministry of Environment and Energy publication entitled "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater", dated July, 1993.

(2) Despite subsection (1), over a period equal to or less than twenty-four hours, each discharger may collect composite samples by taking three equal volume grab samples at intervals of at least four hours and combining them.

(3) Each discharger shall maintain the sampling equipment used at the discharger's plant for sampling required by this Regulation in a way that ensures that the samples collected at the plant under this Regulation accurately reflect the level of discharge of each limited parameter and assessment parameter from the plant.

(4) In accordance with the requirements of subsections 13.3.-(1) and 13.3.-(2), and despite subsection (1), a discharger may calculate a retention time of a waste treatment facility, and where the calculated retention time in relation to a process effluent, excluding minewater effluent and smelter-refinery effluent, at a dischargers plant is thirty days or more, or where the calculated retention time in relation to minewater effluent or smelter-refinery effluent at a discharger's plant is five days or more, a single grab sample of the effluent may be collected during any day on which a sample is required by this Regulation.

(5) A discharger not using cyanide as a process chemical, need not analyze samples collected under sections 17, 18, 19 and 24.1. for total cyanide as set out in schedules 2 and 4.

(6) A discharger need not analyze samples collected under sections 17 and 18 for total cyanide, as set out in schedule 2, when the effluent being collected is minewater effluent.

PART II - SAMPLING POINTS

Establishment and Elimination of Sampling Points

8.-(1) Each discharger shall, by ...., 199., establish a sampling point on each process effluent, cooling water effluent and emergency overflow effluent stream at the discharger's plant, as necessary so that the plant loadings calculated under sections 12, 13 and 13.1 for each limited parameter and assessment parameter and the concentrations determined for each limited parameter and assessment parameter accurately reflect the level of discharge of each parameter from the plant.

(The date that is 90 days after the day on which this Regulation is filed will be inserted in subsection 8(1).)

(2) If circumstances change so that a new sampling point is necessary at a discharger's plant in order to permit the calculation of plant loadings under sections 12, 13 and 13.1 for each limited parameter and assessment parameter and the determination of concentrations for each limited parameter and assessment parameter that accurately reflect the level of discharge of each parameter from the plant, the discharger shall, within thirty days of the change, establish the new sampling point.

(3) A discharger may eliminate a sampling point established under subsection (1) or (2) if the sampling point is no longer necessary to permit the calculation of plant loadings under sections 12, 13 and 13.1 for each limited parameter and assessment parameter and the determination of concentrations for each limited parameter and assessment parameter that accurately reflect the level of discharge of each parameter from the plant.

(4) A plant loading for a parameter or a concentration for a parameter that is based on analytical results that are significantly affected by dilution or masking due to the merging of streams upstream of a sampling point at a plant is not a loading or a concentration that accurately reflects the level of discharge of the parameter from the plant.

(5) In determining what is necessary to meet a discharger's obligations to establish sampling points under this section, the discharger shall consider both which streams should have sampling points and where on a stream a sampling point should be located.

Reports on Sampling Points

9.-(1) By ...., 199., each discharger shall submit to the Director a list and plot plan showing the sampling points established under this Regulation at the discharger's plant as of ...., 199..

(The date that is 100 days after the day on which this Regulation is filed will be inserted in the first line of subsection 9(1). The date that is 90 days after the day on which this Regulation is filed will be inserted in the fourth line of subsection 9(1).)

(2) Within thirty days after establishing a sampling point under this Regulation that is not shown on a list and plot plan submitted under this section, the discharger shall give the Director a written notice describing the location of the sampling point, together with a revised list and plot plan showing the sampling point.

(3) Within thirty days after eliminating a sampling point under this Regulation that is shown on a list and plot plan submitted under this section, the discharger shall give the Director a written notice describing where the sampling point used to be, together with a revised list and plot plan without the sampling point.

Use of Sampling Points Established Under This Part

10. Subject to section 20, each discharger shall use the sampling points established under this Part for all sampling required by this Regulation.

PART III - CALCULATION OF LOADINGS, CONCENTRATIONS AND RETENTION TIMES

Calculation of Loadings - General

11.-(1) For the purposes of performing a calculation under sections 12, 13 and 13.1, a discharger shall use the actual analytical result obtained by the laboratory.

(2) Despite subsection (1), where the actual analytical result is less than one-tenth of the analytical method detection limit set out in the Ministry of Environment and Energy publication entitled "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater" dated July, 1993, the discharger shall use the value zero for the purpose of performing a calculation under sections 12, 13 and 13.1.

(3) Each discharger shall ensure that each calculation of a process effluent loading required by section 12 is performed as soon as reasonably possible after the analytical result on which the calculation is based becomes available to the discharger.

(4) Each discharger shall ensure that each calculation of a cooling water effluent loading required by section 13 is performed in time to comply with subsection 32(4).

(5) Each discharger shall ensure that each calculation of an emergency overflow effluent loading required by section 13.1 is performed in time to comply with subsection 32(5).

Calculation of Loadings - Process Effluent

12.-(1) Each discharger shall calculate, in kilograms, a daily process effluent stream loading for each limited parameter in each process effluent monitoring stream of the discharger for each day on which a sample is collected under this Regulation from the stream for analysis for the parameter.

(2) When calculating a daily stream loading under subsection (1), the discharger shall multiply, with the necessary adjustment of units to yield a result in kilograms, the analytical result obtained from the sample for the parameter by the daily volume of effluent, as determined under section 25, for the stream for the day.

(3) Each discharger shall calculate, in kilograms, a daily process effluent plant loading for each limited parameter for each day for which the discharger is required to calculate a daily process effluent stream loading for the parameter under subsection (1)

(4) For the purposes of subsection (3), a daily process effluent plant loading for a parameter for a day is the sum, in kilograms, of the daily process effluent stream loadings for the parameter calculated under subsection (1) for the day.

(5) Where a discharger calculates only one daily process effluent stream loading for a parameter for a day under subsection (1), the daily process effluent plant loading for the parameter for the day for the purposes of subsection (3) is the single daily process effluent stream loading for the parameter for the day.

(6) Each discharger shall calculate, in kilograms, a monthly average process effluent plant loading for each limited parameter for each month in which a sample is collected under this Regulation more than once from a process effluent monitoring stream at the discharger's plant for analysis for the parameter.

(7) For the purposes of subsection (6), a monthly average process effluent plant loading for a parameter for a month is the arithmetic mean of the daily process effluent plant loadings for the parameter calculated under subsection (3) for the month.

Calculation of Loadings - Cooling Water Effluent

13.-(1) Each discharger shall calculate, in kilograms, a daily cooling water effluent stream loading for each assessment parameter in each cooling water effluent monitoring stream of the discharger for each day on which a sample is collected under this Regulation from the stream for analysis for the parameter.

(2) When calculating a daily stream loading under subsection (1), the discharger shall multiply, with the necessary adjustment of units to yield a result in kilograms, the analytical result obtained from the sample for the parameter by the daily volume of effluent, as determined under section 25, for the stream for the day.

(3) Each discharger shall calculate, in kilograms, a daily cooling water effluent plant loading for each assessment parameter for each day for which the discharger is required to calculate a daily cooling water effluent stream loading for the parameter under subsection (1).

(4) For the purposes of subsection (3), a daily cooling water effluent plant loading for a parameter for a day is the sum, in kilograms, of the daily cooling water effluent stream loadings for the parameter calculated under subsection (1) for the day.

(5) Where a discharger calculates only one daily cooling water effluent stream loading for a parameter for a day under subsection (1), the daily cooling water effluent plant loading for the parameter for the day for the purposes of subsection (3) is the single daily cooling water effluent stream loading for the parameter for the day.

(6) Each discharger shall calculate, in kilograms, a monthly average cooling water effluent plant loading for each assessment parameter for each month in which a sample is collected under this Regulation more than once from a cooling water effluent monitoring stream at the discharger's plant for analysis for the parameter.

(7) For the purposes of subsection (6), a monthly average cooling water effluent plant loading for a parameter for a month is the arithmetic mean of the daily cooling water effluent plant loadings for the parameter calculated under subsection (3) for the month.

Calculation of Loadings - Emergency Overflow Effluent

13.1.-(1) Sections 13.-(1) to 13.-(5) apply with necessary modifications to emergency overflow effluent streams.

Calculation of Concentrations - Process Effluent

13.2.-(1) For each process effluent monitoring stream at a discharger's plant, each discharger shall calculate the average monthly concentration, in milligrams per litre, for each of the parameters for which a limit is set in column 4 of Schedule 2, as soon as reasonably possible.

(2) When calculating a monthly average concentration under subsection (1), a direct discharger shall take the arithmetic mean concentration for samples collected under sections 17 and 18 throughout the month.

(3) Where only one sample is collected under sections 17 and 18 throughout the month, the monthly average concentration for the parameter for the month is the concentration for the sample collected.

Calculation of Retention Time - Process Effluent

13.3.-(1) For each process effluent stream, a discharger may calculate a retention time under subsection 7(4), by expressing, in days, the period of time that results from dividing the average daily flow of a process effluent, expressed in cubic metres, into the total available volume of a waste treatment facility, expressed in cubic metres.

(2) For the purposes of calculating a retention time under subsection (1), a discharger shall use the arithmetic average of thirty days of flow, during which the plant is operating, at a process effluent sampling point in any quarter.

(3) For the purposes of subsection (2), a plant is not considered to be operating when flow is absent at a process effluent sampling point.

PART IV - PARAMETER AND LETHALITY LIMITS

Parameter Limits

14.-(1) Each discharger shall ensure that, for each parameter, the daily plant concentration limit, listed in Column 3 of Schedule 2, is not exceeded.

(2) Each discharger shall ensure that each monthly average concentration limit calculated for a parameter under section 13.2. in connection with the discharger's plant does not exceed the monthly average concentration limit specified for the parameter in Column 4 of Schedule 2.

(3) Subject to subsection (4), each discharger shall control the quality of each process effluent monitoring stream at the discharger's plant to ensure that the pH value of any sample collected at a process effluent sampling point at the plant is within the range of 6.0 to 9.5.

(4) Throughout any day on which a discharger has used an alternate sampling point on a process effluent monitoring stream for sampling required by section 20, as permitted by subsections 20(3) and (4), the discharger,

(a) shall control the quality of the stream to ensure that the pH value of any sample collected at the alternate sampling point on the stream is within the range of 6.0 to 9.5; and

(b) need not comply with subsection (3) with respect to the stream.

Lethality Limits

15. Each discharger shall control the quality of each process effluent monitoring stream and each cooling water effluent monitoring stream at the discharger's plant to ensure that each rainbow trout acute lethality test and each Daphnia magna acute lethality test performed on any grab sample collected at a process effluent sampling point or cooling water effluent sampling point at the plant results in mortality for no more than fifty percent of the test organisms in one-hundred percent effluent.

PART V - MONITORING

Monitoring - General

16.-(1) Despite sections 17 to 22 a discharger need not collect samples from any stream at the discharger's plant on a day on which a process effluent is not discharged from the plant.

(2) Where a discharger is required by this Regulation to pick-up a set of samples and analyze it for certain parameters, the discharger shall pick-up a set of samples sufficient to allow all the analyses to be performed.

(3) A discharger shall use all reasonable efforts to ensure that all analyses required by this Regulation are completed as soon as reasonably possible and that the results of those analyses are made available to the discharger as soon as reasonably possible.

(4) Subject to subsection (5), each discharger shall pick-up all sets of samples required to be picked-up at the discharger's plant under sections 17 and 18 between the hours of 7.00 a.m. and 10.00 a.m..

(5) If the Director is satisfied, on the basis of written submissions from a discharger, that the circumstances at the discharger's plant are such that it would be impractical to pick-up a set of samples from each sampling point established at the plant under this Regulation within the time period specified in subsection (4), the Director may give the discharger a written notice in respect of the plant, varying the time period specified in subsection (4).

(6) Subject to subsections (7) and (8), where a discharger is required by sections (17) or (18) to pick-up a set of samples, the discharger shall pick-up a set collected over the twenty-four hour period immediately preceding the pick-up.

(7) The twenty-four hour period referred to in subsection (6) may be shortened or enlarged by up to three hours to permit a discharger to take advantage of the three hour range specified in subsection (4) or of a different three hour period specified in a notice under subsection (5).

(8) Where a notice has been given under subsection (5) in respect of a plant specifying a time period longer than three hours, the twenty-four hour period referred to in subsection (6) may be shortened or enlarged by up to that longer amount of time to permit the discharger to take advantage of the time period specified in the notice.

(9) If the circumstances at a plant change so that the Director is satisfied that the circumstances described in subsection (5) no longer apply at the plant, the Director may revoke a notice given in respect of a plant under subsection (5) by giving a notice of revocation in writing to a discharger for the plant.

Monitoring - Process Effluent - Daily

17.-(1) Each discharger shall, on each day, pick-up a set of samples collected at each process effluent sampling point at the discharger's plant and shall analyze each set of samples for the parameters for which the frequency of monitoring, as set out in column 2 of Schedule 2 for the discharger's plant, is daily.

(2) A discharger need not meet the requirements of subsection (1) where it is impossible to do so because of sampling by a provincial officer.

Monitoring - Process Effluent - Weekly

18.-(1) Each discharger shall, on one day in each week, pick-up a set of samples collected at each process effluent sampling point at the discharger's plant and shall analyze each set of samples for the parameters for which the frequency of monitoring, as set out in column 2 of Schedule 2 for the discharger's plant, is weekly.

(2) There shall be an interval of at least four days between successive pick-up days at the plant under subsection (1).

(3) All samples picked-up under subsection (1) in a week shall be picked-up on the same day in the week.

Monitoring - Process Effluent -Quality Control

19.-(1) On one day in each year after 1993, on a day on which samples are picked-up at the plant under subsection 18(1), each discharger shall collect and pick-up a duplicate sample for each sample picked-up on that day under subsection 18(1) at one process effluent sampling point at the discharger's plant and shall analyze each duplicate sample for the parameters for which the frequency of monitoring, as set out in column 2 of Schedule 2 for the dischargers plant, is daily or weekly.

(2) Each discharger shall prepare a travelling blank and travelling spiked blank sample for each sample for which a duplicate sample is picked-up at the plant under subsection (1) and shall analyze the travelling blank and travelling spiked blank samples in accordance with the directions set out in the Ministry of Environment and Energy publication entitled "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater", dated July, 1993.

(3) There shall be an interval of at least six months between successive pick-up days at the plant under subsection (1).

Monitoring - Process Effluent - pH Measurement

20.-(1) Each discharger shall, on each day during the time period applicable to the plant under subsection 16(4) or (5), collect a grab sample from each process effluent monitoring stream at the discharger's plant and shall analyze each sample for the parameter pH.

(2) Each grab sample collected under subsection (1) shall be picked-up within four hours of when it was collected.

(3) A discharger shall use either the sampling point established under section 8 on the stream or an alternate sampling point located downstream of the sampling point but before the point of discharge of the stream to surface water or to an industrial sewer used in common with another plant.

(4) Before using an alternate sampling point under subsection (3), a discharger shall give the Director a written notice discribing the location of the alternate sampling point, together with a revised version of the list and plot plan submitted under section 9 showing the alternate sampling point.

Monitoring - Acute Lethality Testing - Rainbow Trout

21.-(1) Where a discharger is required by this section to perform a rainbow trout acute lethality test, the discharger shall perform the test according to the procedures described in the Environment Canada publication entitled "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout", dated July, 1990.

(2) Each rainbow trout acute lethality test required by this section shall be carried out as a single concentration test using one hundred percent effluent.

(3) On one day in each month, on a day on which samples are picked-up at the plant under subsection 18(1), each discharger shall collect and immediately pick-up a grab sample at each process effluent sampling point at the discharger's plant and shall perform a rainbow trout acute lethality test on each sample.

(4) There shall be an interval of at least fifteen days between successive pick-up days at the plant under subsection (3).

(5) All samples picked-up under subsection (3) in a month shall be picked-up on the same day in the month.

(6) Where a discharger has performed tests under subsection (3) for twelve consecutive months on samples collected from the same sampling point and the mortality of the rainbow trout in each test did not exceed fifty percent, the discharger is relieved of the obligations under subsection (3) relating to the sampling point and shall instead collect and immediately pick-up a grab sample at the sampling point on one day in each quarter and perform a rainbow trout acute lethality test on each sample.

(7) Samples picked-up at a plant under subsection (6) shall be picked-up on a day on which samples are picked-up at the plant under subsection (3).

(8) If no samples are being picked-up at a plant under subsection (3) during a quarter, samples picked up at the plant during the quarter under subsection (6) shall be picked-up on a day on which samples are picked-up at the plant under subsection 18(1).

(9) There shall be an interval of at least forty-five days between successive pick-up days at the plant under subsection (6).

(10) All samples picked-up under subsection (6) in a quarter shall be picked-up on the same day in the quarter.

(11) If a rainbow trout acute lethality test performed under subsection (6) on any sample from a sampling point results in mortality of more than fifty percent of the test rainbow trout, subsections (6) to (10) cease to apply in respect to samples from that sampling point, and a discharger shall instead comply with the requirements of subsection (3) relating to the sampling point, until the tests performed under subsection (3) on all samples collected from the sampling point for a further twelve consecutive months result in mortality for no more than fifty percent of the rainbow trout for each test.

(12) A discharger shall notify the Director in writing of any change in the frequency of acute lethality testing under this Regulation at the discharger's plant, within thirty days after the day on which the change begins.

(13) A discharger may notify the Director in writing of any period in which the testing of samples collected at a sampling point under subsection (3) would always result in mortality of more than fifty percent of the test rainbow trout.

(14) Where a notice is given under subsection (13), a discharger is relieved of the obligations under subsection (3) relating to the sampling point during the period in which the testing of samples collected at the sampling point would always result in mortality of more than fifty percent of the test rainbow trout.

(15) Subsections (13) and (14) are revoked on ...., 199..

(The date on which Part IV of this Regulation comes into force will be inserted in subsection 21(15).)

(16) Subsections (2) to (15) apply with necessary modifications to each cooling water effluent sampling point and, for the purpose, the reference in subsection (3) to each process effluent sampling point shall be deemed to be a reference to each cooling water effluent sampling point and the reference in subsections (3) and (8) to subsection 18(1) shall be deemed to be a reference to subsection 24(1).

Monitoring - Acute Lethality Testing - Daphnia magna

22.-(1) Where a discharger is required by this section to perform a Daphnia magna acute lethality test, the discharger shall perform the test according to the procedures described in the Environment Canada publication entitled "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna", dated July, 1990.

(2) Subsections 21(2) to (15) apply with necessary modifications to Daphnia magna acute lethality tests and, for the purpose, a reference to rainbow trout shall be deemed to be a reference to Daphnia magna.

(3) Each discharger shall pick-up each set of samples required to be collected from a sampling point at the discharger's plant under this section on a day on which the discharger collects a sample from the sampling point under section 21, to the extent possible having regard to the frequency of monitoring required at the sampling point under this section and section 21.

Monitoring - Chronic Toxicity Testing - Fathead Minnow and Ceriodaphnia Dubia

23.-(1) Where a discharger is required to perform a 7-day fathead minnow growth inhibition test, the discharger shall perform the test according to the procedure described in the Environment Canada publication intitled "Biological Test Method: Test of Larval Growth and Survival Using Fathead Minnows" dated February, 1992.

(2) Where a discharger is required to perform a 7-day Ceriodaphnia dubia reproduction inhibition and survivability test, the discharger shall perform the test according to the procedure described in the Environment Canada publication entitled "Biological Test Method: Test of Reproduction and Survival Using The Cladoceran Ceriodaphnia dubia", dated February, 1992.

(3) On one day in each semi-annual period, on a day on which samples are picked-up at the plant under subsection 18(1), each discharger shall collect and immediately pick-up a grab sample from each process effluent sampling point at the discharger's plant, and shall perform a 7-day fathead minnow growth inhibition test and a 7-day Ceriodaphnia dubia reproduction inhibition and survivability test on each sample.

(4) There shall be an interval of at least ninety days between successive pick-up days at the plant under subsection (3).

(5) All samples picked-up under subsection (3) in a semi-annual period shall be picked-up on the same day in the semi-annual period.

(6) A discharger need not collect a sample from a sampling point in accordance with subsection (3) until twelve consecutive monthly rainbow trout acute lethality tests and twelve consecutive monthly Daphnia magna acute lethality tests performed on samples collected at the sampling point at a discharger's plant result in mortality for no more than fifty percent of the test organisms in one hundred percent effluent.

Monitoring - Cooling Water Effluent - Weekly Assessment

24.-(1) Each discharger shall, on one day in each week, pick-up a set of samples collected at each cooling water effluent sampling point at the discharger's plant and shall analyze each set of samples for each assessment parameter.

(2) There shall be an interval of at least four days between successive pick-up days at the plant under subsection (1).

(3) All samples picked-up under subsection (1) in a week shall be picked-up on the same day in the week.

Monitoring -Emergency Overflow Effluent - Daily Assessment

24.1.-(1) Each discharger shall, on each day that an emergency overflow effluent is discharged from the plant, pick-up a set of samples collected at each emergency overflow effluent sampling point at the discharger's plant and shall analyze each set of samples for each assessment parameter.

(2) There shall be an interval of at least twelve hours between successive pick-up days at the plant under subsection (1).

PART VI - EFFLUENT VOLUME

Flow Measurement

25.-(1) For the purposes of this section, a volume of effluent for a stream for a day is the volume that flowed past the sampling point, established under Part II on the stream, during the twenty-four hour period preceding the pick-up of the first sample picked up from the stream for the day.

(2) Each discharger shall determine in cubic metres a daily volume of effluent for each process effluent stream at the discharger's plant for each day on which a sample is collected under this Regulation from the stream.

(3) Despite subsection (2), where a process effluent stream discharges on an intermittent basis, the daily volumes for the stream may be determined either by integration of continuous flowrate measurements or by the summation of individual batch volume measurements.

(4) Each discharger shall use flow measurement methods that allow the daily volumes for process effluent streams to be determined to an accuracy of within plus or minus fifteen percent.

(5) Each discharger shall determine in cubic metres a daily volume of effluent for each cooling water effluent stream and each emergency overflow effluent stream at the discharger's plant for each day on which a sample is collected under this Regulation from the stream.

(6) Each discharger shall use flow measurement methods that allow the daily volumes for cooling water effluent and emergency overflow effluent streams to be determined to an accuracy of within plus or minus twenty percent.

(7) Each discharger shall, no later than the day that this section comes into force, determine by calibration or confirm by means of a certified report of a registered professional engineer of the Province of Ontario that each flow measurement method used under subsections (2) and (3) meets the accuracy requirements of subsection (4) and that each flow measurement method used under subsection (5) meets the accuracy requirements of subsection (6).

(8) Where a discharger uses a new flow measurement method or alters an existing flow measurement method, the discharger shall determine by calibration or confirm by means of a certified report of a registered professional engineer of the Province of Ontario that each new or altered flow measurement method meets the accuracy requirements of subsections (4) or (6), as the case may be, within two weeks after the day on which the new or altered method or system is used.

(9) Each discharger shall develop and implement a maintenance schedule and a calibration schedule for each flow measurement system installed at the discharger's plant and shall maintain each flow measurement system according to good operating practices.

(10) Each discharger shall use reasonable efforts to set up each flow measurement system used for the purposes of this section in a way that permits inspection by a provincial officer.

Calculation of Plant Volumes

26.-(1) Each discharger shall calculate, in cubic metres, a daily process effluent plant volume for each day.

(2) For the purposes of subsection (1), a process effluent plant volume for a day is the sum of the daily process effluent volumes determined under section 25 for the day.

(3) Each discharger shall calculate, in cubic metres, a monthly average process effluent plant volume for each month, by taking the arithmetic mean of the daily process effluent plant volumes calculated under subsection (1) for the month.

(4) Each discharger shall calculate, in cubic metres, a daily cooling water effluent plant volume for each day.

(5) For the purposes of subsection (4), a cooling water effluent plant volume for a day is the sum of the daily cooling water volumes determined under section 25 for the day.

(6) Each discharger shall calculate, in cubic metres, a monthly average cooling water effluent plant volume for each month, by taking the arithmetic mean of the daily cooling water effluent plant volumes calculated under subsection (4) for the month.

(7) Each discharger shall calculate, in cubic metres, a total emergency overflow effluent plant volume for each day on which an emergency overflow effluent is discharged from the plant.

(8) For the purposes of subsection (7), an emergency overflow effluent plant volume for a day is the sum of the daily emergency overflow effluent volumes determined under section 25 for the day.

PART VII - STORM WATER CONTROL STUDY

Storm Water Control Study

27.-(1) Each discharger shall complete a storm water control study in respect of the discharger's plant, in accordance with the requirements of the Ministry of Environment and Energy publication entitled "Protocol for Conducting a Storm Water Control Study", dated August, 1993.

(2) A discharger need not comply with subsection (1) in respect of the discharger's plant if,

(a) the plant meets the exemption criteria set out in the Ministry of Environment and Energy publication entitled "Protocol for Conducting a Storm Water Control Study", dated August, 1993; and

(b) the discharger notifies the Director in writing, by ...., 199., that the plant meets the exemption criteria referred to in clause (a).

(The date that is one year after the day on which this Regulation is filed will be inserted in clause 27(2)(b).)

(3) Subject to subsection (4), a discharger shall complete the storm water control study in respect of the discharger's plant by ...., 199..

(The date that is two years after the day on which this Regulation is filed will be inserted in subsection 27(3).)

(4) A discharger may postpone completion of the storm water control study in respect of the discharger's plant until January 1, 1997 if,

(a) in order to meet the requirements of Part IV, the discharger plans to make process changes, install waste water treatment facilities, implement management practices, or make any other changes at the plant that would likely alter the quantity or quality of storm water discharged from the plant; and

(b) the discharger notifies the Director in writing, by ...., 199., of the plans referred to in clause (a).

(The date that is two years after the day on which this Regulation is filed will be inserted in subsection 27(4).)

(5) Each discharger shall ensure that a copy of each study completed under this section is available to Ministry staff at the discharger's plant, on request, during the plant's normal office hours.

PART VIII - RECORDS AND REPORTS

Record Keeping

28.-(1) Each discharger shall keep records, in an electronic format acceptable to the Director, of all analytical results obtained under sections 17, 18 and 20, all calculations performed under sections 12, 13, 13.1, 13.2 and 13.3 and all determinations and calculations made or performed under sections 25 and 26.

(2) Each discharger shall keep records of all sampling and analytical procedures used in meeting the requirements of section 7, including, for each sample, the date, the time of pick-up, the sampling procedures used, and any incidents likely to affect the analytical results.

(3) Each discharger shall keep records of the results of all monitoring performed under sections 19 and 21 to 24.

(4) Each discharger shall keep records of all maintenance and calibration procedures performed under section 25.

(5) Each discharger shall keep records of all problems or malfunctions, including those related to sampling, analysis, acute lethality testing, chronic toxicity testing or flow measurement, that result or are likely to result in a failure to comply with a requirement of this Regulation, stating the date, duration and cause of each malfunction, and including a description of any remedial action taken.

(6) Each discharger shall keep records of any incident in which process effluent is discharged from the discharger's plant without flowing past a sampling point established on a process effluent stream in accordance with this Regulation before being discharged, stating the date, duration, cause and nature of each incident.

(7) Each discharger shall keep records of all process changes and redirections of or changes in the character of effluent streams that affect the quality of effluent at any sampling point established under this Regulation at the discharger's plant.

(8) Each discharger shall keep records of the location of each sampling point established at the discharger's plant under Part II.

(9) Each discharger shall make each record required by this section as soon as reasonably possible and shall keep each such record for a period of three years.

(10) Each discharger shall ensure that all records kept under this section are available to Ministry staff at the discharger's plant, on request, during the plant's normal office hours.

Reports Available to the Public

29.-(1) On or before June 1 in each year, each discharger shall prepare a report relating to the previous calendar year and including,

(a) a summary of plant loadings calculated under sections 12, 13 and 13.1

(b) a summary of the results of monitoring performed under sections 17, 18 and 20 to 24;

(c) a summary of calculations performed under subsections 26(1), (4) and (7).

(d) a summary of the loadings, concentrations or other results that exceeded a limit prescribed by section 14 or 15; and

(e) a summary of the incidents in which process effluent was discharged from the discharger's plant without flowing past a sampling point established on a process effluent stream in accordance with this Regulation before being discharged.

(2) Each discharger shall ensure that each report prepared under subsection (1) is available to any person, at the discharger's plant, on request, during the plant's normal office hours.

(3) Each discharger shall provide the Director, upon request, with a copy of any report that the discharger has prepared under subsection (1)

Reports to the Director - General

30.-(1) Each discharger shall notify the Director in writing of any change of name or ownership of the discharger's plant occurring after ...., 199., within thirty days after the end of the month in which the change occurs.

(The date that is the day on which this Regulation is filed will be inserted in subsection 30(1))

(2) Each discharger shall notify the Director in writing of any process change or redirection of or change in the character of an effluent stream that affects the quality of effluent at any sampling point established under this Regulation at the discharger's plant, within thirty days of the change or redirection.

(3) A discharger need not comply with subsection (2) where the effect of the change or redirection on effluent quality is of less than one week's duration.

Reports to the Director on Compliance with Section 6 and Part IV

31.-(1) Each discharger shall report any incident in which process effluent is discharged from the discharger's plant without flowing past a sampling point established on a process effluent stream in accordance with this Regulation before being discharged.

(2) Each discharger shall report any loading, concentration or other result that exceeds a limit prescribed by section 14 or 15.

(3) A report required under subsection (1) or (2) shall be given orally, as soon as reasonably possible, and in writing, as soon as reasonably possible.

Quarterly Reports to the Director

32.-(1) No later than forty-five days after the end of each quarter, each discharger shall submit a report to the Director containing information relating to the discharger's plant throughout the quarter as required by subsections (3) to (10).

(2) A report under this section shall be submitted both in an electronic format acceptable to the Director and in hard copy generated from the electronic format and signed by the discharger.

(3) A report under this section shall include all information included in a report given under section 31 during the quarter.

(4) Each discharger shall report, for each month in the quarter, the monthly average plant loadings and the highest and lowest daily plant loadings calculated under sections 12 and 13 for each limited parameter and each assessment parameter.

(5) Each discharger shall report, for each month in the quarter, the concentration and the daily emergency overflow effluent plant loading, for each assessment parameter listed in Schedule 4, for each day on which an emergency overflow effluent is measured.

(6) Each discharger shall report, for each month in the quarter, the monthly average concentration calculated under section 13.2 and the highest and lowest daily concentrations for each month in the quarter, for each limited parameter and for each assessment parameter.

(7) Each discharger shall report, for each month in the quarter, the monthly average process effluent plant volume and the highest and lowest daily process effluent plant volumes calculated under section 26.

(8) Each discharger shall report, for each month in the quarter, the monthly average cooling water effluent plant volume and the highest and lowest daily cooling water effluent plant volumes calculated under section 26.

(9) Each discharger shall report the number of days and the dates in each month in the quarter on which process effluent, cooling water effluent and emergency overflow effluent was discharged from the dischargers plant.

(10) Each discharger shall report, for each month in the quarter, the highest and lowest pH results obtained under section 20 for each process effluent monitoring stream at the discharger's plant.

Reports to the Director on Chronic Toxicity Testing

33.-(1) Each discharger shall report to the Director the results of all monitoring performed under section 23, together with the date on which each sample was picked-up, no later than sixty days after the end of each semi-annual period in which the monitoring was performed.

(2) A report under subsection (1) shall include a plot of percentage reduction in growth or reproduction against the logarithm of test concentration and shall include a calculation of the concentration at which a twenty-five percent reduction in growth or reproduction would occur.

PART IX - COMMENCEMENT AND REVOCATION PROVISIONS

Revocation of O.Reg. 359/88

34. Ontario Regulation 359/88 is revoked on ...., 199..

(The date that is 90 days after the day on which this Regulation is filed will be inserted in section 34.)

Commencement of Parts IV, V AND VI

35.-(1) Part IV comes into force on January 1, 1996.

(2) Parts V and VI come into force on ...., 199..

(The date that is 90 days after the day on which this Regulation is filed will be inserted in subsection 35(2).)

Schedule 1:

List of Regulated Plants

Plant Name
All Existing and New Plants

Schedule 2:

Process Effluent Limits and Monitoring Frequency

PLANT:	All Existing and New Plants			
ATG	Parameter	Monitoring Frequency	Daily Concentration Limit	Monthly ** Average Concentration Limit
			mg/L	mg/L
	Column 1	Column 2	Column 3	Column 4
2	Total Cyanide	W, D *	2	1
8	Total Suspended Solids (TSS)	D	30	15
9	Copper	W	0.6	0.3
	Lead	W	0.4	0.2
	Nickel	W	1	0.5
	Zinc	W	1	0.5
10	Arsenic	W	1	0.5

Explanatory Notes:

D = Daily monitoring requirement
W = Weekly monitoring requirement
ATG = Analytical Test Group
mg/L = milligrams per litre
* = Operating gold mines only
** = St. Andrew Goldfields Limited, Stock Mine:
Nickel = 0.3, Zinc = 0.1
** = American Barrick Resources Corporation Limited, Holt-McDermott Mine:
Lead = 0.1, Nickel = 0.2, Zinc = 0.1

Schedule 3:

Cooling Water Assessment Monitoring Requirements

PLANT:	All Existing and New Plants	
ATG	Parameter	Monitoring Frequency
	Column 1	Column 2
8	Total Suspended solids (TSS)	W

Explanatory Notes:
W = Weekly monitoring requirement
ATG = Analytical Test Group

Schedule 4:

Emergency Overflow Assessment Monitoring

PLANT:	All Existing and New Plants	
ATG	Parameter	Monitoring Frequency
	Column 1	Column 2
2	Total Cyanide	D
8	Total Suspended Solids (TSS)	D
9	Copper	D
	Lead	D
	Nickel	D
	Zinc	D
10	Arsenic	D

Explanatory Notes:
D = Daily monitoring requirement
ATG = Analytical Test Group

Technology Trains in Place
(Spring, 1992)

Appendix 2

of the

Development Document

MISA METAL MINING SECTOR

TECHNOLOGY TRAINS IN PLACE (spring, 1992)

(01) Inco Copper Cliff Treatment Plant

pH adjustment (using lime)
coagulation (using polymer)
settling (2 clarifiers)

(02) Inco Crean Hill Mine

batch lime treatment on surface
primary pond for hydroxide settling
polishing pond

(03) Falconbridge NIR

primary settling pond (tailings area)
lime treatment
settling pond (natural wetland)

(04) Inco Garson Mine

lime treatment on surface
settling pond
polishing pond

(05) Noranda Geco Mine

lime treatment
polymer addition
settling (clarifier)

(06) Falconbridge Kidd Creek Mine

lime treatment
settling pond
polishing pond

(07) Inco Levack Mine

lime (added at main sump before tailings area)
settling (tailings area)

(08) Falconbridge Lockerby Mine

alkaline underground flow
settling pond (minewater-solids removal)
recycle/polishing pond

(09) Falconbridge Kidd Metallurgical site

lime
settling (tailings pond)

(10) Inco Nickel Refinery (Sudbury)

lime addition to thickener
collection pond
settling pond

(11) Inco Nolin Creek Treatment Plant

lime addition
polymer addition
settling (clarifier)

(12) Falconbridge Onaping Mine

sodium hydroxide addition
settling pond

(13) Inco Port Colborne Refinery

lime addition
polymer addition
settling pond

(14) Inco Shebandowan Mine

(sodium carbonate used in mill)
settling (tailings area)

(15) Falconbridge Strathcona Mine

tailings area (settling/oxidation)
lime addition
settling (part of lake)
carbon dioxide addition

(16) Inco Whistle Mine

lime batch treatment
settling pond
polishing pond

(17) Minnova Winston Lake Mine

lime addition
sludge settling pond
carbon dioxide addition (winter operation only)
polishing pond

(19) Dickenson (Arthur W. White): Campbell Mines

both primary settling in individual tailings areas
common polishing area (Balmer Lake)

Note: At Campbell, lime added to effluent from pressure leach system, metal precipitates settled in lined pond; overflow to tailings area

(21) Canamax Bell Creek Mine

primary settling (tailings area)
polishing pond

(24) Teck-Corona, David Bell Mine

cyanide destruction (lime, copper sulphate, hydrogen peroxide)
antimony removal (lime, ferric sulphate)
pH adjustment (using lime)
flocculant addition
settling (clarifier)

(25) Placer Dome Detour Lake Mine

primary settling (tailings area: natural degradation)
secondary clearwater pond
alkaline chlorination used but failed to yield required results; was replaced by hydrogen peroxide plant
tertiary clearwater pond

(26) Placer Dome Dome Mine

primary settling (tailings area)
natural degradation

(27) Placer Dome Dona Lake Mine

primary settling (tailings pond)
polishing pond
(natural degradation)

(28) Eastmaque Gold Mines

primary settling (tailings pond)

(processing tailings only)

(29) Giant Yellowknife ERG

primary settling (tailings area)
natural degradation
air/sulphur dioxide treatment

(30) Hemlo Gold Golden Giant Mine

lime, copper sulphate, ferrous sulphate addition
hydrogen peroxide
flocculant addition
clarification with sludge recycle

(31) Canamax Kremzar Mine

primary settling (tailings area)
secondary clearwater pond
(natural degradation)

(32) LAC Minerals Macassa Division

primary settling (tailings area)
conditioning pond
hydrogen peroxide treatment (copper sulphate, flocculants)
sludge settling pond
polishing ponds

(35) Canamax Marlhill Mine

primary settling pond
secondary settling pond

(36) American Barrick McDermott Mine

primary settling (tailings area) (north basin)
polishing pond (south basin)
(natural degradation)

(37) Bond Gold Golden Patricia Mine

primary settling (tailings area)
secondary polishing pond
(natural degradation)

(38) Williams Operating Corporation Williams Mine

Minewater: initial settling; underground sumps
sedimentation pond
polishing pond

Process Effluent: primary settling (tailings area)
hydrogen peroxide (copper sulphate)(when necessary)
lime addition
ferric chloride
flocculent

(39) Giant Yellowknife Pamour #1 Mine

primary settling (tailings area)
(natural degradation)

(42) Renabie Gold Mines

primary settling
polishing pond
(natural degradation)

(45) St. Andrews Gold Fields

primary settling (natural degradation)
sulphur dioxide air system
polishing pond

(46) Algoma Steel, Ore Division

primary settling (tailings area)
polishing pond

(51) Denison Mines, Denison Property

pH adjustment at mill
primary settling (tailings area)
barium chloride addition (radium control)
polishing pond

(52) Rio Algom (Lacnor/Nordic)

pH adjustment (lime)
polishing pond

(53) Rio Algom (Panel)

primary settling (tailings area)
lime and barium chloride addition
polishing ponds

(54) Rio Algom (Pronto)

holding pond
barium chloride addition
lime addition
heavy metal settling pond
polishing pond

(55) Rio Algom (Quirke)

primary settling (tailings area)
lime and barium chloride additions
settling and polishing ponds

(56) Cameco Refinery (Blind River)

sodium carbonate addition
settling in lagoon

(57) Cameco Refinery (Port Hope)

cooling water only (no treatment)

(58) Rio Algom Stanleigh Mine

primary settling (tailings area)
lime, barium chloride addition
flocculant addition
filtration (dual media filters)

(59) Denison Mines Stanrock property

lime, barium chloride addition
settling pond
polishing pond

The INCO Sulphur Dioxide/Air Cyanide Destruction Process

Appendix 3

of the

Development Document

THE INCO SO_2/AIR CYANIDE DESTRUCTION PROCESS

Date: January 31, 1991

The Inco SO_2/Air Process

1. General Process Description

The Inco SO_2/Air process for total cyanide removal is based on oxidation of CN^- to CNO^- using mixtures of SO_2-O_2 as the oxidizing agent in the presence of soluble copper, which acts as a catalyst, in a controlled pH range. The O_2 is supplied by air. The soluble Cu catalyst can be present in the effluent to be treated or can be added to the effluent in solid or solution form (eg. $CuSO_4 \cdot 5H_2O$ or $Cu(OH)_2$). pH can be controlled by suitable bases (eg. $Ca(OH)_2$ or NaOH).

There are actually two fundamental ways the cyanide is removed in the process. The first is by oxidation to CNO^-, which occurs for all free CN^- and weakly or moderately bound metal CN^- complexes. It is in this way that the weak acid dissociable, cyanide (CN_W) is removed. The second form of CN^- removal by this process is confined to only the strong complexes of Fe, which are reduced to the ferrous state by the process and continuously precipitated as insoluble ferrocyanide salts of the general formula $M_2Fe(CN)_6$, where M can be Cu, Zn or Ni.

SCN^- can be removed as well by the process, but is effectively oxidized by SO_2/Air only after the CN^- has been removed. This, it will be seen later, is an advantage in conserving reagents for the most toxic species. In general, during routine CN_T removal, between 5-20% of the SCN^- will also be oxidized. Any more than that requires further retention time, further reagents and possibly different catalysts.

The process has been successfully applied on a wide variety of barren solutions, pond waters, heap leach solutions. and tailings slurries. There appears to be no upper limit of CN_T that can be treated down to <1 mg/L CN_T and often as low as 0.1 mg/L CN_T, but treatment conditions, final effluent quality and process control may vary depending on the composition of the solution or slurry. Table 1 summarizes the history of plant-scale operations to date. A typical flowsheet of the Inco SO/Air process is shown in Figure 1.

Figure 1

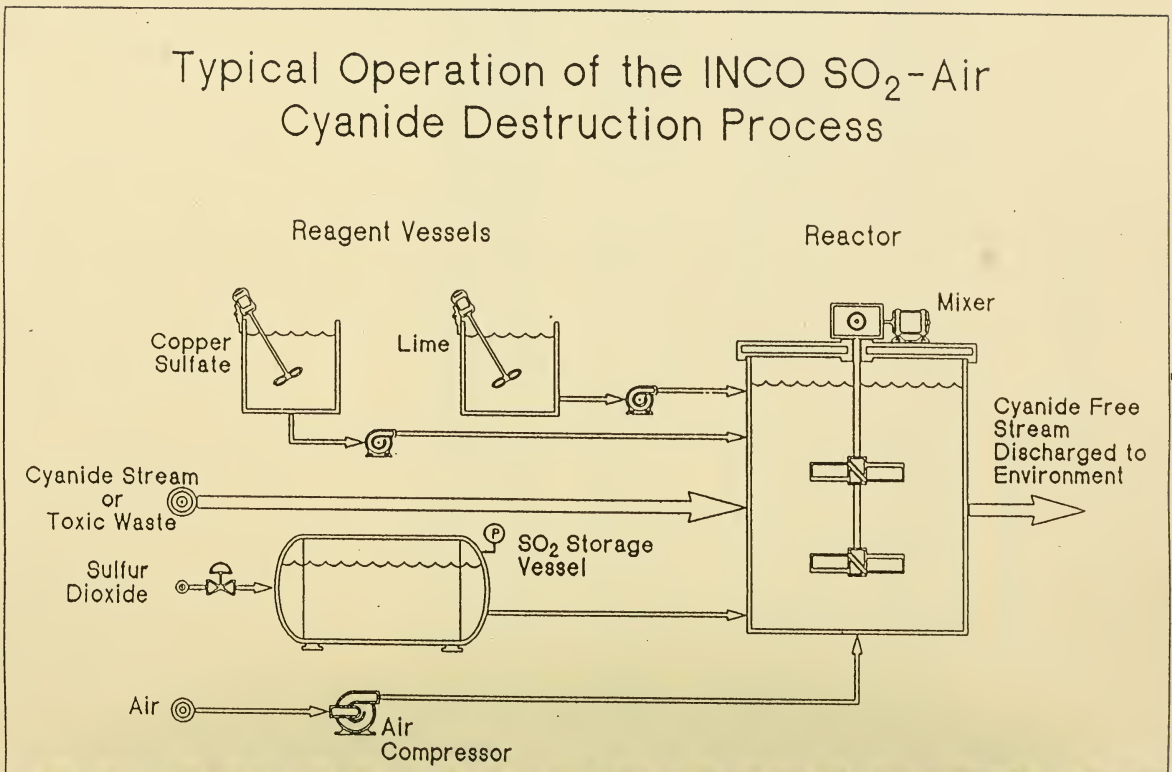

Typical Operation of the INCO SO_2-Air Cyanide Destruction Process
Reagent Vessels
Reactor
Copper Sulfate
Lime
Mixer
Cyanide Free Stream Discharged to Environment
Cyanide Stream or Toxic Waste
SO_2 Storage Vessel
Sulfur Dioxide
Air
Air Compressor

Table 1
Inco SO_2/Air process - Operational History

Mine	Location	Treatment Application	Process Start Up	Process Shut Down
Scottie Gold Mine	B.C.	barren-slurry	1982	1984
Dupont Exploration-Baker	B.C.	slurry	1983	1983
Caroline Mines	B.C.	barren	1983	1984
Equity Silver	B.C.	slurry	1985	operating
Inco-Queenston / McBean	Ontario	barren	1985	1987
Mount Skukum	Yukon	slurry	1986	1988
Colosseum	California	slurry	1987	operating
Lynngold	Manitoba	pond	1987	1989
Kuntz	Ontario	plating	1987	operating
Canamax / Ketza	Yukon	slurry	1988	1990
ERG	Ontario	pond	1988	1989
Inco-Golden Knight / Casa Berardi	Quebec	slurry	1988	operating
Placer Dome / Kiena	Quebec	slurry	1989	operating
Skyline Explorations / Johnny Mountain	B.C.	slurry	1989	1989
Citadel / Surluga	Ontario	barren	1989	1989
Mineral Hill	Montana	barren	1989	operating
Minova / Lac Shortt	Quebec	pond	1989	operating
Precious Plate	Ontario	plating	1989	operating
Superfinish	Ontario	plating	1989	operating
Westmin / Premier	B.C.	slurry	1989	operating
Golden Bear	B.C.	slurry	1989	operating
Muschocho / Montauban	Quebec	pond	1989	1990
Echo Bay/ Kettle River	Washington	slurry	1990	operating
Sable Res / Baker	B.C.	barren	1990	1990
St. Andrew Goldfield	Ontario	pond	1990	operating
Barrick Mercur	Utah	pond	1990	operating
Lac Mineral-Bousquet	Quebec	slurry	1990	operating
Sunshine / Snow Caps	California	heap rinse	1990	operating
Echo Bay / McCoy-Cove	Nevada	slurry	1990	operating
Hope Brook Gold	NFLD	slurry	1990	operating
IBM	Quebec	waste water	1990	operating

2. Cyanide Destruction Chemistry

The oxidation of cyanide to cyanate with the Inco process is given below:

$$CN^- + SO_2 + O_2 + H_2O \longrightarrow CNO^- + H_2SO_4 \quad (1)$$

This reaction requires copper to be present to act as a catalyst. The copper concentration in solution should be about 20 ppm Cu (or more) for stable operation. If the copper necessary for the catalyst is too low for stable operation, copper can be added as a solution of copper sulfate.

Based on reaction (1) the theoretical requirement of SO_2 to CN is only 2.47 g SO_2/g CN^-, but due to SO_2 consumption by other chemical reactions the SO_2 dosage is greater.

The temperature has little effect on the CN^- oxidation reaction. Other commercial cyanide destruction processes are sensitive to temperature.

The oxygen needed for reaction (1) is conveniently obtained from air as it bubbles through the solution or slurry. Only a small fraction of the oxygen that enters the bottom of the reactor in the air is actually transferred to the solution. Once the oxygen is in the solution, it can then react with SO_2 and CN^-. If one can measure 1 to 2 ppm O_2 dissolved oxygen in the reactor, then there is enough oxygen being transferred to satisfy the reaction requirements. If there is less than 1 ppm O_2 in the reactor, there may be insufficient oxygen being transferred and destruction performance will suffer (oxygen starvation).

The sulfuric acid generated during the oxidation of cyanide (and other oxidation reactions) is neutralized with lime to form calcium sulfate, commonly known as gypsum:

$$Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 \ell 2H_2O \quad (2)$$

The cyanide destruction feed contains weak metallo-cyanide complexes that are decomposed as follows;

$$Zn(CN)_4^{2-} \longrightarrow Zn^{2+} + 4\ CN^- \quad (3)$$

$$Ni(CN)_4^{2-} \longrightarrow Ni^{2+} + 4\ CN^- \quad (4)$$

$$Cu(CN)_4^{3-} \longrightarrow Cu^{+} + 4\ CN^- \quad (5)$$

Copper, as cuprous ion, is oxidized to the cupric ion form with the Inco process before it is precipitated as copper hydroxide.

$$2\ Cu^+ + SO_2 + O_2 + 2H^+ \longrightarrow 2\ Cu^{2+} + H_2SO_4 \quad (6)$$

The liberated metal ions are then precipitated as metal hydroxides.

$$Zn^{2+} + 2\ OH^- \longrightarrow Zn(OH)_2 \quad (7)$$

$$Ni^{2+} + 2\ OH^- \longrightarrow Ni(OH)_2 \quad (8)$$

$$Cu^{2+} + 2\ OH^- \longrightarrow Cu(OH)_2 \quad (9)$$

Iron cyanide complexes are not decomposed. Ferricyanide is reduced to ferrocyanide with SO_2 then the ferrocyanide forms a metallo-ferrocyanide complex which is precipitated with available metal ions. $M^{2+} = \{Zn^{2+}, Ni^{2+}$ or $Cu^{2+}\}$

$$2\ Fe(CN)_6^{3-} + SO_2 + 2\ OH^- \longrightarrow 2\ Fe(CN)_6^{4-} + H_2SO_4 \quad (10)$$

$$2\ M^{2+} + Fe(CN)_6^{4-} + x\ H_2O \longrightarrow M_2Fe(CN)_6 * x\ H_2O \quad (11)$$

Other strong cyanide complexes such as gold cyanide, $Au(CN)_2^-$, silver cyanide, $Ag(CN)_2^-$, and mercury cyanide, $Hg(CN)_4^=$ are not destroyed by the Inco process. Laboratory work indicates that none of the gold cyanide is destroyed and perhaps only as much as 15% of the silver cyanide is destroyed.

Sulfur compounds are only partially oxidized by the SO_2/Air process only when there is very little cyanide present in the reactor and excess SO_2 is being added.

$$SCN^- + 4\ SO_2 + 4\ O_2 + 5H_2O \longrightarrow CNO^- + 5H_2SO_4 \quad (12)$$

$$2\ S_2O_3^{2-} + SO_2 + O_2 + 2\ H_2O \longrightarrow S_4O_6^{2-} + H_2SO_4 + 2\ OH^- \quad (13)$$

$$S_4O_6^{2-} + 7\ SO_2 + 7\ O_2 + 12\ H_2O \longrightarrow 11\ H_2SO_4 + 2\ OH^- \quad (14)$$

If the SO_2 finds nothing to be oxidized and there is plenty of oxygen around, then the SO_2 self-destructs according to the following reaction :

$$2\ SO_2 + O_2 + 2\ H_2O \longrightarrow 2\ H_2SO_4 \quad (15)$$

However, if there is no oxygen around, the SO_2 simply precipitates as calcium sulfite. The calcium sulfite will dissolve in the tailings cell and destroy additional cyanide present there. This reaction is given below :

$$Ca(OH)_2 + H_2SO_3 \longrightarrow CaSO_3 + 2\,H_2O \qquad (16)$$

The cyanate ion, CNO^-, is not stable and will hydrolyse to carbonate and the ammonium ion. The reaction below is greatly accelerated at low pH.

$$CNO^- + 2\,H_2O \longrightarrow CO_3^{=} + NH_4^+ \qquad (17)$$

The carbonate ion, which is essentially dissolved CO_2, will precipitate as calcium carbonate. The ammonium ion is in equilibrium with ammonia. At high pH, most of the ammonium ion has been converted to ammonia. The ammonia will exit the water system as ammonia gas in the grinding mills and leach tanks where the pH is high. The equilibria is given below :

$$NH_3 + H^+ \longrightarrow NH_4^+ \qquad (18)$$

The reclaim water will be saturated in sulfates. The sulfates will precipitate with calcium when the pH is raised. Reclaim water should only be added into thickeners where the precipitating calcium sulfate can deposit on the solids rather than on the walls on tank and inside pumps.

3. Equipment Required

SO_2 Supply	:	Dissolution tanks for Na_2SO_3 or $Na_2S_2O_5$; or Liquid SO_2 storage tank with appropriate liquid delivery and flowmeter controls; or Roaster gas (0.5-5 vol. % SO_2) or S° burner.
Air Supply	:	Maximum air dispersion into small bubbles is essential. Proper design required.
Cu^{++}	:	When insufficient copper is present in the feed, then Cu^{++} is best added as a $CuSO_4$ solution.
$Ca(OH)_2$	:	When required, it is best added from a slurry circuit.

pH Control : Industrial pH electrodes may be connected to valves for lime addition.

Reaction Vessel : Generally any vessel of any geometry may be used provided it is well-mixed and has suitable air dispersion. Short-circuiting can be minimized by proper feed and exit locations. The vessel may be open if desired. The number of vessels required is dependent on the treatment desired. Multiple stages are not required but may be desired to treat barren and tailings separately. Barren and tailings may, however, be treated in a single vessel.

4. Operational Control

The successful operation of the process is dependent on proper retention time, air volume and dispersion, SO_2 addition, Cu addition and pH. Air volume and dispersion and tank size (retention) are fixed by design. Process control is therefore carried out by SO_2 and Cu addition at a controlled pH, which is maintained by $Ca(OH)_2$ or NaOH or by $Na_2SO_3/Na_2S_2O_5$ ratio addition. Given an optimum pH from empirical work, process control then simply is reduced to two variables.

SO_2 Addition : The amount of SO_2 added is adjusted based on the total weight of CN_T to be removed, which is obviously derived from the volume of effluent to be treated and its CN_T analysis (or estimates thereof). In general Inco has found 2-5 g SO_2/g CN_T is necessary, but each effluent has its own particular SO_2 addition for optimum performance. Large excesses of SO_2 addition are to be avoided.

Cu Addition : The Cu requirement for successful operation of the process must be determined experimentally. Generally <50 mg/L Cu is satisfactory for most effluents, but for certain high Fe-containing effluents, it is necessary to leave additional Cu present to precipitate ferrocyanide salt.

Miscellaneous : Colour and cyanide electrode readings give very good indications of successful treatment, but must be characterized for each specific effluent.

5. Operating Characteristics

5.1 Treated Effluent Quality

Treatments in a continuous lab apparatus by Inco have shown that the total cyanide can be generally reduced to <0.5 mg/L CN_T. Typical results are summarized in Table 3. The SCN oxidation ranges between 5-20%. Most of the CN^- is reporting as CNO^-, but some hydrolyses to NH_3 and CO_2 with time. Metal values such as Cu, Fe, Ni and Zn are reduced to below 1 mg/L with copper as an exception in some cases.

Table 2
Laboratory Cyanide Removal Results from Continuous Treatment

Company	Type of Effluent	Stream	Total Ret'n (min)	pH	Assays (mg/L) CN_T	Cu	Fe	Reagents (g/g CN_T) SO_2	Cu^{2+}
Campbell Red Lake	Barren	Feed	60	11.1	940	39	118		
	Solution	Effluent		10.0	0.7	0.6	0.2	3.0	0.15
Equity	CIP Tailings	Feed	30	10.0	195	42	25		
	(30% Solids)	Effluent		8.0	0.4	1.1	0.2	3.8	0.25
Mount Skukum	Tailings	Feed	40	9.8	215	3.0	40		
	(45% Solids)	Effluent		8.0	0.3	0.2	0.1	2.1	0.50
Lynngold	Pit Water	Feed	20	8.7	13	1.5	0.1		
		Effluent		9.9	0.6	0.4	0.1	4.8	0.40
Colosseum	CIP Tailings	Feed	80	10.5	243	84	85		
	(53% Solids)	Effluent		8.0	0.3	0.9	0.2	4.3	0
Kuntz	Electroplating	Feed	100		100	54	4.5		
	Rinse Water	Effluent		8.5	2.1	3.2	0.6	3.6	0.50
McBean	Barren Solution	Feed	90	11.7	404	35	26		
		Effluent		9.0	0.3	0.5	<0.2	3.5	0
Skyline	Repulped Tailings	Feed	120	10.4	1124	455	73		
		Effluent		8.0	1.5	2.7	0.1	4.0	0
Inco/Golden Knight	CIL Tailings	Feed	60	10.5	200	15	2.4		
		Effluent		8.0	0.2	0.9	0.2	4.6	0.2
ERG	Pond Water	Feed	40	9.0	155	88	6.5	6.5	0
		Effluent		7.7	0.1	0.3	<0.1		
Westmin	CIP Tailings	Feed	120	10.7	278	24	13	5.3	0.07
		Effluent		8.0	0.3	0.8	0.1		

5.2 Disposal of Treated Effluent

No subsequent treatment of effluent from the process is envisioned other than solids removal in a tailings pond and pH adjustment of any discharge of pond supernatant, if required.

5.3 Stability and Disposal of Precipitates

Metal hydroxides and gypsum formed in the process will remain with the tailings in the pond. The stability of the ferrocyanide precipitates formed in the process is high according to the literature. Brief testing carried out by Inco over the range pH 4 to 9 indicated no significant redissolution of cyanide from these solids as a function of time. There appears to be an equilibrium concentration of CN_T with ferrocyanide solids of about 0.5 mg/L CN_T(see Table 3), since this value was attained from both higher and lower concentrations in contact with process solids.

5.4 Recycle Suitability

From experience available on full-scale operations, there is no adverse effect on mill chemistry on using pond recycle from this process. Specific water chemistry demands of certain locations will have to be addressed individually.

Table 3
Stability of Solids Formed

Stream	Time (Days)	Assays (wt %)* or (mg/L) pH	CN_T	Cu	Fe	Zn
Effluent	0	9.0	8.0	0.5	2.7	0.2
Residue*	0	-	8.4	8.8	3.0	0.6
Effluent	21	8.7	2.0	3.0	<0.1	0.3
Effluent	64	8.4	0.5	2.1	0.1	0.5
Effluent	0	9.0	<.1	0	<0.5	0.6
Residue*	0	-	8.35	0	3.0	9.0
Effluent	8	7.8	0.1	-	<0.5	0.6
Effluent	34	7.6	0.2	-	<0.1	0.2
Effluent	113	7.3	0.4	-	<0.1	2.2

6. Plant Performance

6.1 CIP, CIL or Repulped Tailings

The Inco SO_2/Air process is suited for the removal of cyanide from carbon in pulp (CIP), or carbon in leach (CIL) or repulped leach tailings. This is because reagent consumption is virtually unaffected by sulfide and oxide ores.

Operations currently using the Inco process on tailings are Lac Minerals' Colosseum (3 kt/d or 3300 stpd), Canamax's Ketza River (400 t/d or 440 stpd), Equity Silver (9 kt/d or 9900 stpd), Inco-Golden Knight's Casa Berardi (1.2 kt/d or 1300 stpd), Westmin's Premier Gold (2 kt/d or 2200 stpd), Placer-Dome's Kiena (1.3 kt/d or 1400 stpd), Homestake-Chevron's Golden Bear (400 t/d or 440 stpd) Echo Bay's Kettle River (2 kt/d or 2200 stpd) and McCoy/Cove (8 kt/d or 8800 stpd), Lac Mineral's Bousquet Two (1.5 kt/d or 1650 stpd) and Hope Brook Gold Mine (3.5 kt/d or 3850 stpd). Typical results are shown in Table 4. In these operations cyanide destruction is usually carried out in single stage reactors equipped with suitable agitation mechanisms and aeration. With a few exceptions, liquid SO_2 is used as it is one of the most economical and available SO_2 sources. For maximum process efficiency, the pH is controlled in an optimum range which is dependent on feed solution chemistry and type of ore present in the feed pulp.

The treatment of pulps before discharge has several advantages over a facility designed to reduce the cyanide concentration by natural degradation. Removal of cyanide by natural degradation requires collection ponds that must be lined (sometimes double-lined) or be large enough to maintain acceptable cyanide levels compatible with surrounding ground water. The cost of liners and/or dam construction is well documented. In Canada, and certain areas of the U.S., where rain and snowfall are high, discharge from tailings ponds is often required. In a natural degradation system further treatment would be required prior to discharge. Relying on secondary treatment can also result in pond water balance concern if the treatment capacity is exceeded by precipitation inflow rates. An operation runs the risk of temporary plant shut down during periods of inclement weather if an unmanageable pond overflow is anticipated. The problem of migratory birds utilizing cyanide contaminated ponds is also of increasing concern as has been demonstrated in Nevada as well as many other jurisdictions.

All of the above problems are overcome with destruction of cyanide at the source using the Inco process. A relatively small unlined pond can be used resulting in substantial capital cost savings. By using natural degradation as a polishing step, tailings pond levels can be easily managed year round while providing a safe habitat for migratory birds.

Other key advantages of slurry treatment are the provision of clean solids for underground backfill operations and of clean recycle water to flotation circuits and grinding mills treating preg-robbing carbonaceous feed.

Finally, natural degradation ponds characteristically direct operators towards maintaining low cyanide concentrations in leach solutions. Many ores require high strength cyanide solution for maximum recovery. Slurry treatment provides this opportunity without complicating pond conditions.

Table 4
Treatment of CIP or CIL Tailings
Plant Results

Mine	Stream	Assays (mg/L)				Reagent Usage (g/g CN_{TOT})	
		CN_{TOT}	Cu	Fe	SO_2	Lime	Cu^{2+}
Colosseum	CIP Tails	364	39	1.1			
	Effluent	0.4	1.5	0.2	4.6	0.12	0.04
Ketza River	CIP Tails	150	10	-			
	Effluent	5	10	-	6.0	0	0.30
Equity	CIP Tails	175	30	2.0			
	Effluent	2.3	3.6	<0.1	3.4	0	0.03
Casa Berardi	CIP Tails	150	8	4			
	Effluent	1.0	2.4	0.2	4.5	-	0.10
Westmin Premier	CIP Tails	150	25	2.0			
	Effluent	<0.2	0.5	<0.1	5.8	-	0.12
Golden Bear	CIP Tails	205	1.6	0.7			
	Effluent	0.3	0.7	0.2	2.8	-	-

6.2 Barren Solution, Pond Water, Heap Leach Rinse Solution

Despite the obvious advantage of treating pulps, mining operations can sometimes take advantage of natural degradation. Plants using the Merril-Crowe gold recovery process will often only have to treat barren bleed solution to control cyanide levels in holding ponds. In cases where large natural ponds are available many companies choose to treat pond water bleed into a polishing pond prior to discharge to the environment.

Operations that have chosen the SO_2/Air process on barren solution are Inco-Queenston's McBean (11 m^3/hour or 388 cu ft per hour), American Copper & Nickel - Homestake's Mineral Hill (14 m^3/hour or 494 cu ft per hour) and Citadel (5 m^3/hour or 176 cu ft per hour). At Mineral Hill for example there can be no net discharge to the environment and barren solution is therefore collected in a small lined pond after treatment. The pond water is used as process water and to wash tailing solids. Washed solids are impounded on a lined surface from which any seepage is collected and recycled to the cyanide destruction facility.

Treatment of pond water into a polishing pond was implemented on a seasonal basis (about six months per year) at Lynngold's MacLellan (100 m^3/hour or 3531 cu ft per hour), Minova's Lac Shortt (170 m^3/hour or 6003 cu ft per hour) and St. Andrew Goldfield's Stock Mine (170 m^3/hour or 6003 cu ft per hour). Typical plant results for barren or pond treatment are summarized in Table 5. In all these operations a single reaction tank is usually used with the same design criteria as used for pulp treatment.

Recently Inco has been involved in applying its process to the rinsing and detoxification of heap leach pads which are widely present in the U.S. At Sunshine's Snow Caps operation in California, the existing barren solution pond was converted into a SO_2/Air reactor with minimal capital cost. Treatment is on 500 gallons per minute of return water from the heap and cyanide was reduced from 180 to 4 mg/L in less than five months of solution recirculation.

Table 5
Treatment of Barren Solution or Pond Water
Plant Results

Mine	Stream	Assays (mg/L)			Reagent Usage (g/g CN_{TOT})		
		CN_{TOT}	Cu	Fe	SO_2	Lime	Cu^{2+}
McBean	Barren	370	20	40			
	Effluent	0.2	0.4	0.1	4.0	4.0	0
Lynngold	Pond	146	16	2.7			
	Effluent	0.4	0.4	<0.1	6.2	7.0	0.08
Mineral Hill	Barren	129	47	38			
	Effluent	1.5	0.9	0.5	6.0	9.0	0
Lac Shortt	Pond	10	0.8	3.0			
	Effluent	0.9	0.01	0.9	5.0	-	0

6.3 Plating Shops

Plating shop rinse waters or concentrated cyanide wastes have been successfully treated with the Inco SO_2/Air process. Most shops currently use alkaline chlorination to detoxify their wastes in-house. Problems arise however, in the handling of hypochlorite reagent solution and as well as in treatment efficiency. Municipal guidelines for discharge of solutions into sewer systems are increasingly more demanding. Many shops therefore, have to collect their cyanide waste and ship them out for treatment at high cost. The Inco SO_2/Air process can readily accommodate the stricter guidelines. The process is easily applied to plating shop effluents using sodium metabisulfite (or sodium sulfite) as the SO_2 source. In most cases, existing reactors can be used requiring minimum capital for the adaptation.

Three installations in Ontario have already switched from chlorination to SO_2/Air and typical results achieved are summarized in Table 6.

Table 6
Treatment of Electroplating Wastes
Plant Results

Mine	Stream	Assays (mg/L)			Reagent Usage (g/g CN_{TOT})		
		CN_{TOT}	Cu	Fe	SO_2	Lime	Cu^{2+}
Kuntz	Waste	150	90	2.8			
	Effluent	0.2	1.2	<0.2	6.0	-	-
Precious Plate	Waste	30,300	9,200	1,820			
	Effluent	60	289	<0.1	2.7	0.6	0
Superfinish	Waste	640	32	19			
	Effluent	1.3	-	<0.1	3.4	-	0.02

7. Capital Costs

Capital costs for the Inco SO_2/Air process depend on the type of treatment required and the size of the operation. The main capital items are a reaction tank, a mixer with motor and support, an air compressor (or blower) with associated piping, an SO_2 reagent system with associated instrumentation and piping, a copper sulfate delivery system (when required) and a lime delivery system.

For a large installation (3 kt/d or 3300 stpd) requiring 5 to 10 t/d (5.5 to 11 stpd) of SO_2 and treating pulps for total cyanide detoxification, the principle equipment cost is about C $ 500,000, or about C $ 1.2 million installed.

Alternatively, the same operation only requiring seasonal pond water treatment can have a cost of C $ 500,000 installed. In many cases existing equipment can be used for operations switching to the Inco process.

For temporary installations such as required for heap rinsing, the capital cost can be minimized by converting the existing barren solution pond into the SO_2/Air reactor. The SO_2 delivery system can be leased and only requires the installation of a delivery line. Air blowers can also be leased and existing lime (or caustic) systems can be used for pH control.

8. Operating Costs

Operating costs including reagents, labour, electric power, maintenance and licensing fees vary between 10 cents to C $ 1.75/t (9 cents to C $ 1.58 per st) of ore.

The lower operating costs are for treatment of pond water where the advantage of natural degradation can be taken. A typical operating cost for a plant treating CIP tailings using liquid SO_2 is C $ 1.30/t (C $ 1.18 per st).

One of the main advantages of the Inco SO_2/Air process is the low cost of SO_2, which is available in many forms. The least expensive is roaster gas (when available) and, in increasing order of cost, elemental sulfur burning, liquid SO_2, and sodium sulfite or sodium metabisulfite. Hope Brook implemented the Inco SO_2/Air process in late 1990 converting from a previous H_2O_2 system. It is the first plant using an elemental sulfur burner to produce SO_2. The capital cost of the sulfur burner should be recovered in six months as a result of reduced operating costs over the use of liquid SO_2.

Prices vary depending on location, but in Canada, liquid SO_2 can be obtained at 12 to 25 cents/kg (5.5 to 11 cents per lb) SO_2; SO_2 from elemental sulfur at 7 cents/kg SO_2 (3 cents per lb) and metabisulfite at 77 cents/kg (35 cents per lb) SO_2. These costs are highly competitive with the costs of hydrogen peroxide, chlorine, sodium or calcium hypochlorite or chlorine dioxide.

9. Comments

9.1 Advantages

- Removes CN_T to low levels (0.1 mg/L achievable).
- Removes metals to low levels (0.1 mg/L achievable).
- Removes $Fe(CN)_6^{-4}$.
- Can be applied to solution or slurry.
- Necessary equipment is simple, cheap, and readily available.
- Existing equipment is easily retrofitted.
- Process control is simple and can be manually or automatically done.
- Reactions are rapid.
- No toxic gaseous intermediates are produced.

- Reagent consumption is low and therefore operation is inexpensive.
- CN^- oxidation occurs in preference to SCN^-.
- Process design is flexible.
- Inco is available for effluent testing and engineering assistance.

9.2 Disadvantages

- Each effluent responds in a unique way and must be tested for proper process control.
- SCN^- oxidation is not rapid under most conditions and is typically only 5% removed.
- Process has been patented and must be licensed.
- CNO^- and/or NH_3 are not oxidized further, should this prove to be necessary.

10. References

1. Borbely, G.J., et al., Can Patent 1, 165474, granted April, 1984, to Inco Ltd. and U.S. Patent 4,537,686, granted August 27, 1985, to Inco Ltd.

2. Devuyst, E.A., Ettel, V.A. and Borbely, G.J., 1982a, "New Method for Cyanide Destruction in Gold Mill Effluents and Tailing Slurries". Presented at 14th Annual Operators' conf. of the CMP-CIM, Ottawa, Jan. 19-21, 1982.

3. Devuyst, E.A., Ettel, V.A. and Borbely, G.J., 1982b, "New Process for Treatment of Wastewaters Containing Cyanide and Related Species". Presented at AIME, Dallas, Feb. 14-18, 1982.

4. Devuyst, E.A., Ettel, V.A. and Borbely, G.J. and Conard, B.R., 1982, "A New Process for the Treatment of Wastewaters Containing Cyanide and Related Species". Presented at CIM, Toronto, Aug. 29, 1982.

5. Devuyst, E.A., Conard, B.R. and Ettel, V.A., 1982, "Pilot Plant Operation of the Inco SO_2/Air Cyanide Removal Process". Presented at 29th Ont. Ind. Waste Conf., Toronto, June 13, 1982 and Can. Mining Journal, Aug. 1982, p. 27-30.

6. Devuyst, E.A., Mosoiu, A. and Krause, E., 1983, "Oxidizing Properties and Applications of the SO_2-O_2 System". Proceedings of 3rd Int'l Symp. on Hydrometallurgy, AIME, Atlanta, Georgia, Mar. 6, 1983.

7. Conard, B. and Tessier, M., 1983, "Inco Develops Cyanide Removal Process". The Northern Miner, April 21, 1983.

8. Nutt, S.G. and Zaidi, S.A., 1983, "Treatment of Cyanide-Containing Wastewaters by the Cu-catalyzed SO_2/Air Oxidation Process". Presented at 38th Ann. Purdue Ind. Waste Conference, West Lafayette, Ind., May 10, 1983.

9. Devuyst, E.A, Conard, B.R. and Hudson, W., 1982, "Commercial-scale Trials of the Inco SO_2/Air Cyanide Removal Process". Presented at the Canada/EC Seminar, Treatment of Complex Minerals, Ottawa, Ont., Oct. 12-14, 1982.

10. Lewis, A., 1984, "New Inco Tech Process Attacks Toxic Cyanides", Eng. and Min. Journal, 185(7), p. 52 (1984).

11. Devuyst, E.A., Conard, B.R. and Hudson, W., 1984a, "Industrial Application of the Inco SO_2/Air Cyanide Removal Process". Presented at the 1st Int'l. Symp. Prec. Metals Recovery, Reno, Nevada, June, 1984.

12. Devuyst, E.A., Conard, B.R. and Hudson, W., 1984b, "Commercial Operation of Inco's SO_2/Air Cyanide Removal Process". Proceedings of the Conference on Cyanide and The Environment, Tucson, Arizona, Dec. 11-14, 1984.

13. Devuyst, E.A., Conard, B. R., Vergunst, R. and Tandi, B., 1989, "A Cyanide Removal Process Using Sulfur Dioxide and Air". Journal of Metals, Dec., p. 43, 1989.

14. Devuyst, E.A., 1990, "SO_2/Air Cyanide Destruction", Hazardous Materials Management Magazine, June, p. 48, 1990.

Degussa Hydrogen Peroxide

Cyanide Destruction Technology

Appendix 4

of the

Development Document

Degussa Canada Ltd.

Cyanide Destruction Technology
Operations Overview

for

Ontario
Ministry of the Environment

August30,1991

Degussa Canada Ltd.

Cyanide Destruction Technology
Operations Overview

A) Hydrogen Peroxide User Location and Status

B) Process Description by Company and Usage Type

Section I

Corona Corporation - Nickel Plate Mine

a) Process Description
b) Figure I - December 1988 Detox Data

Section II

Corona Corporation - Jolu Mine

a) Process Description
b) Figure I - Detox Plant Data (Total Cyanide)
c) Figure II - Detox Plant Data (Copper)

Section III

Corona Corporation - Renabie Mine

a) Process Description
b) Figure I - 1991 Polishing Pond Detox Data

Section IV

Placer Dome Inc. - Detour Lake Mine

a) Process Description
b) Figure I - May 1991 Treatment Data

Section V

Lac Minerals - Macassa Mine

a) Process Description
b) Diagram of Effluent Treatment System
c) Figure I - April 1991 Cu Discharge Results
d) Figure II - April 1991 Total Cyanide Discharge Results
e) Figure III - May 1991 Cu Discharge Results

Section VI

Lac Minerals Ltd. - East Malartic

a) Process Description
b) Diagram of Pond System with Reagent Dosage Points
c) Figure I - Emergency Detox Data

Section VII

Cambior Inc. - Yvan Vezina Mine

a) Plant Detoxification

a) Process Description
b) Figure I - July Plant Discharge Data
c) Figure II - July Plant Feed Data

b1) Emergency Polishing Pond Detoxification

a) Process Description

b2) Emergency Tailings Pond Overflow Detoxification

a) Process Description
b) Figure I - Emergency Pond Detox Data

Section VIII

Granges Exploration Ltd. - Tartan Lake Mine

a) Process Description
b) Figure I - November 1988 Discharge Data

Section IX

Pioneer Metals Corporation - Puffy Lake Mine

a) Process Description

Hydrogen Peroxide User Location and Status

User Name	*User Location*	*Status*
Corona Corp. Nickle Plate Mine	Penticton B.C.	Continuing
Corona Corp. Jolu Mine	near La Ronge Sask.	Closing Aug, 1991
Corona Corp. Renabie Mine	Missanabie Ont.	Closing Sept., 1991
Placer Dome Inc. Detour Lake Mine	Detour Lake Ont.	Continuing Seasonally
Lac Minerals Ltd. Macassa Mine	Kirkland Lake Ont.	Continuing Seasonally
Lac Minerals Ltd. East Malartic Mine	Malartic Que.	Seasonal Treatment
Cambior Inc. Yvan Vezina Mine	Destor Que.	Continuing Seasonally
Granges Inc. Tartan Lake Mine	Flin Flon Man.	Closed 1989
Pioneer Metals Ltd. Puffy Lake Mine	Sherridan Man.	Closed 1989

SECTION I

COMPANY: CORONA CORP. - Nickel Plate Mine

DETOXIFICATION METHOD: Barren Bleed Detox

DETOXIFICATION PERIOD: Continuous

FEED EFFLUENT TYPE: Barren Bleed

VOLUME TREATED/HOUR: 136 m3

REAGENT REQUIREMENT:

a) 576 kg 100% H_2O_2/hour

b) lime slurry

c) Copper Sulphate Pentahydrate

d) Sulphuric acid

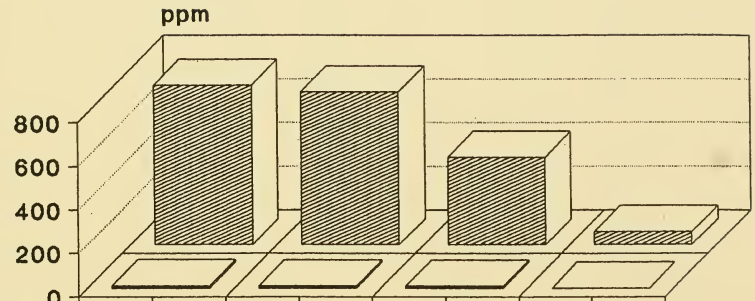
PROCESS DESCRIPTION:

At Nickel Plate a barren bleed is treated year - round to treat their cyanide effluent to within their tailings pond limits of 25 ppm total cyanide. Because of high iron in the bleed a two stage detoxification system was designed. The treatment plant was designed so that barren bleed would flow through and be treated in four cascading reactor tanks. Following this treatment the barren would be repulped with the tailings filter cake and then pumped to the tailings pond. In the first treatment tank the lime slurry, the copper sulphate and 70% was dosed to oxidize the cyanide. If ferrocyanide does exist in the circuit, sulphuric acid and copper sulphate could be added in the third tank. The method actually used for the precipitation of the ferrocyanide is to dose sulphuric acid into the tailings line after the repulping process.

EFFLUENT QUALITY:

Refer to the accompanying graph.

NICKEL PLATE MINE
December 1988 Detox Data



	CNt	CNwad	Cu	Fe
Plant Feed	730	700	400	60
Plant Discharge	10	8	8	0.1

Figure I

SECTION II

COMPANY: CORONA CORPORATION - Jolu Mine

DETOXIFICATION METHOD: Tailings Pond Overflow

DETOXIFICATION PERIOD: Seasonally from June to October

FEED EFFLUENT TYPE: Tailings Pond Overflow

VOLUME TREATED/ANNUM: 200 000 m3

REAGENT REQUIREMENT:

a) Hydrogen Peroxide= 35 tonnes 100%

b) $Fe_2(SO_4)_3$ = 136 tonnes 44%

c) Hydrated lime = 61 tonnes solid

d) Flocculant = 7.6 tonnes

PROCESS DESCRIPTION:

To perform the detoxification of the tailings pond overflow a system of four tanks was used. In the first tank the pH was increased to 11.8 using a lime slurry. In the second tank the hydrogen peroxide was dosed to perform the cyanide oxidation reaction. Tank #3 was used as a retention tank. In the fourth tank the ferric sulphate and flocculant were dosed in order to aid in the settlement of the metals following the cyanide oxidation stage. To settle the metals two polishing ponds were employed prior to the discharge to the environment.

EFFLUENT QUALITY:

Refer to the accompanying graph

JOLU GOLD MINE

Detox Plant Data-Total Cyanide

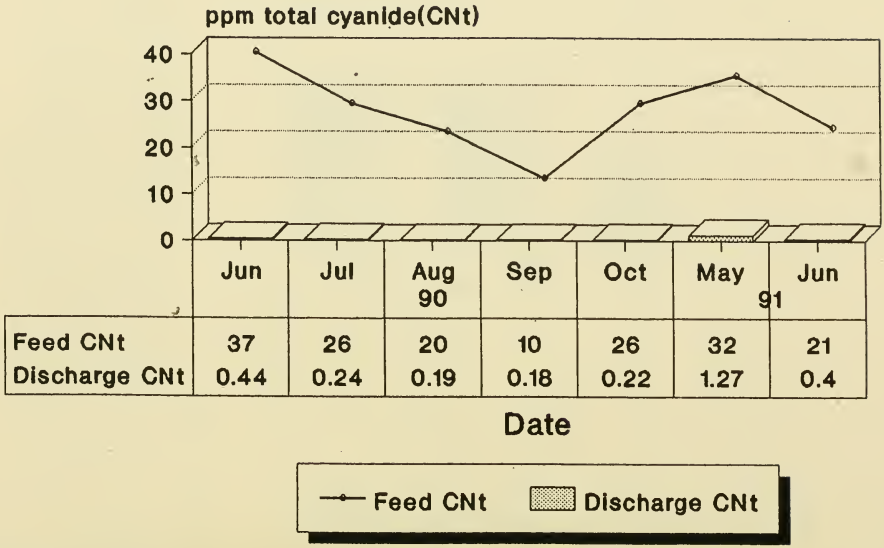
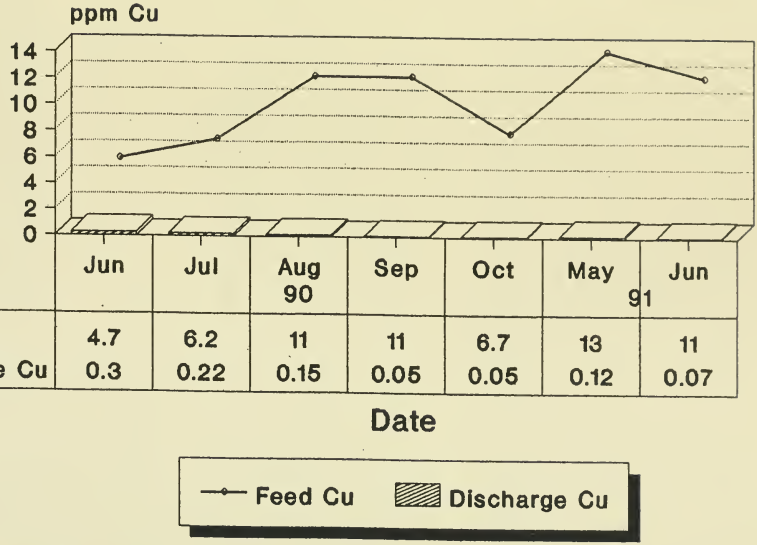


Figure I-Feed vs. Discharge

JOLU GOLD MINE

Detox Plant Data-Total Copper



	Jun	Jul	Aug 90	Sep	Oct	May 91	Jun
Feed Cu	4.7	6.2	11	11	6.7	13	11
Discharge Cu	0.3	0.22	0.15	0.05	0.05	0.12	0.07

Figure II-Feed Vs. Discharge

SECTION III

COMPANY: Corona Corporation - Renabie Mine

DETOXIFICATION METHOD: Emergency Pond Detoxification

DETOXIFICATION PERIOD: March - July, 1991

FEED EFFLUENT TYPE: Polishing Pond

VOLUME TREATED/ANNUM: about 1.4 million m3.

REAGENT REQUIREMENT:

a) 170 tonnes 100% Hydrogen Peroxide

b) $Fe_2(SO_4)_3$ as a 44% solution

PROCESS DESCRIPTION:

a) Lime Pre-treatment

Prior to dosing hydrogen peroxide, lime was added as a solid in order to raise the pH of the polishing pond water to greater than 10.5. This was done in order to make the detoxification reaction more efficient. The lime was blown under the ice at opposite ends of the polishing pond.

b) Hydrogen Peroxide Dosage

When Renabie began their detoxification, they had two dirty ponds. The main tailings pond and the polishing pond. Into each of these ponds there was some effluent flow. Into the tailings pond was the flow from the mill and into the polishing pond was a minute overflow from the main tailings pond. Since the detoxification was started in late February, the hydrogen peroxide was dosed under the ice. Initially, drums of 50% hydrogen peroxide were siphoned into holes made in the ice using a gas auger. At the same time hydrogen peroxide was trickled into the main tailings pond overflow in order

to account for the extra cyanide running into the polishing pond. Once the drums were dosed into the polishing pond it was determined that this was not sufficient enough hydrogen peroxide to complete the treatment. To remedy this 20 tonne bulk truckloads of hydrogen peroxide were delivered on-site. Three holes were drilled in the ice at different corners of the pond where the hydrogen peroxide was then dosed using a gas powered pump from the truck to the addition points. Hydrogen peroxide was dosed in the same fashion into the main tailings pond in an attempt to reduce the cyanide concentration of the overflow going into the polishing pond. Hydrogen peroxide was dosed by truck until a road restriction was placed on the mine road, forcing the return to using drums for peroxide addition. Until May the cyanide was not dropping as expected. To solve this problem the peroxide was shock dosed in a large volume forcing a complete detox reaction to occur. Doing this completed the final detoxification of the tailings pond.

c) Ferric Sulphate Addition

About seven days after the initial hydrogen peroxide additions, Renabie began dosing ferric sulphate into the polishing pond by drums which were syphoned through the ice. With the dosage of ferric sulphate one of the key things is to have sufficient mixing. To attempt to do this a pump was placed at the feed end of the polishing pond. The effluent was then pumped through piping around the polishing pond to the discharge end of the pond. After the ferric sulphate addition was complete, the pump was turned off to allow for settling of the solids in the water.
This procedure was continued throughout the length of the treatment period.

EFFLUENT QUALITY:

a) Refer to figure I for the effluent quality from beginning to end of the treatment period.

COMMENTS:

a) Lime Addition:

Before the lime addition of the pond the pH was approximately 8. Following the lime addition the pH was 9.5. This was as high as the pH could be raised in the pond. No matter how much lime was added this is the highest the pH could be increased. This can be attributed by poor mixing under the ice.

b) Hydrogen Peroxide Addition:

The addition of the peroxide under ice proved to be highly inefficient for the detoxification because of the lack of enough mixing. Without mixing it was assumed that as the peroxide convected through the water, it reacted with the pond bottom which

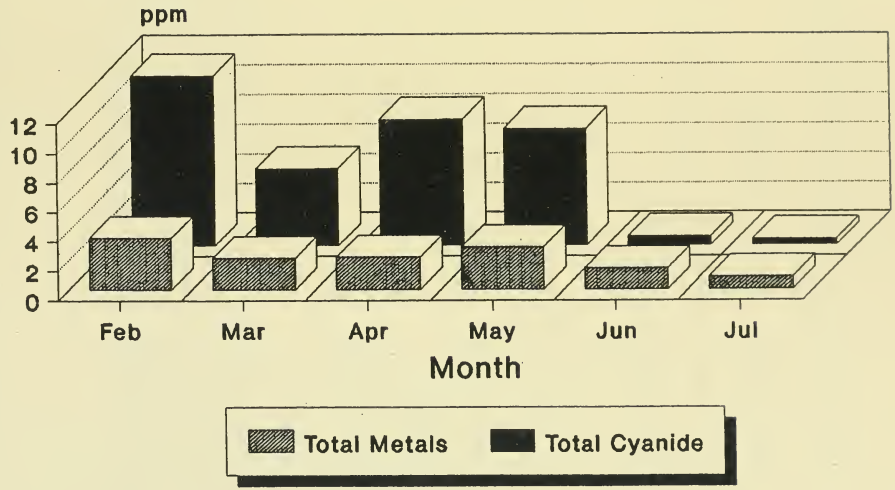
would have caused some decomposition of the hydrogen peroxide. Therefore when the pond was shock treated the peroxide oxidized the cyanide before any real decomposition effects were realized. Also affecting the detoxification was the inflow of more cyanide from the tailings pond, especially during the spring run-off.

c) Ferric Sulphate Addition:

Ferric sulphate was dosed under the ice making mixing very difficult again even though the pond was being slowly recirculated. Also hampering the ferric sulphate was the slow oxidation of the pond water. With some of the cyanide still in the pond it would be impossible to drop all of the metals from suspension. Once the total treatment was complete, the metals settled out immediately.

RENABIE GOLD MINES

1991 Polishing Pond Detox Data



CNt Limit= 2 ppm Metals Limit= 1 ppm

Figure I - Monthly Averages

SECTION IV

COMPANY: PLACER DOME INC. - Detour Lake Mine

DETOXIFICATION METHOD: Seasonal Tailings Pond Overflow

DETOXIFICATION PERIOD: April - June

FEED EFFLUENT TYPE: Tailings pond overflow

VOLUME TREATED IN MAY/91: 369 550 m3

REAGENT REQUIREMENT:

a) 59.3 tonnes slaked lime

b) 67.4 tonnes 100% H_2O_2

PROCESS DESCRIPTION:

Detour Lake has a permanent detoxification plant situated at the discharge of the main tailings pond. The tailings pond overflow is siphoned to the first of three reaction tanks. Each reaction tank is agitated to ensure good mixing. Initially Detour adjusts the pH of the effluent to 11 or higher with lime slurry while dosing hydrogen peroxide into the first tank. The tanks are used for retention following which the detoxified effluent is discharged to the polishing pond. Here the metals are allowed to settle out of solution.

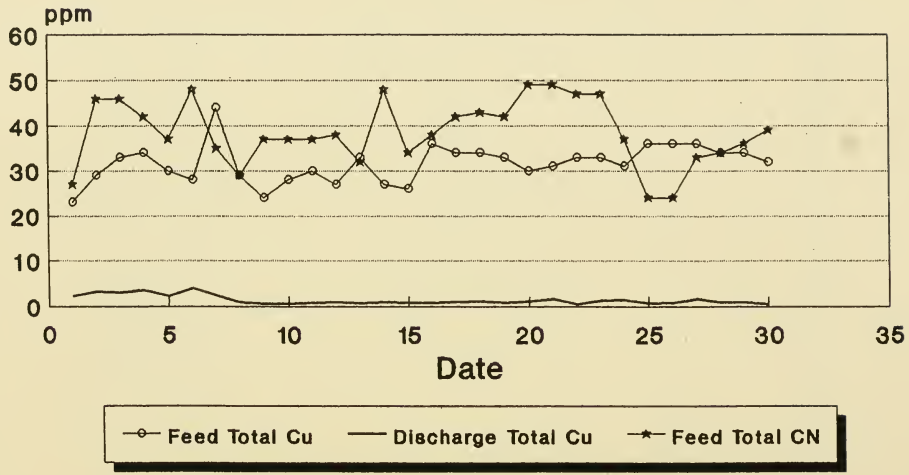
EFFLUENT QUALITY:

Refer to the appended graph. In the graph the results of the discharge total copper are unclear, but are on average less than 1.5 ppm.

COMMENTS:

Detour has no problem achieving cyanide detoxification, but does have trouble settling copper in the polishing pond because its small capacity.

DETOUR LAKE MINE
May 1991 Treatment Data



Average Discharge CNt= 0.4 ppm
CNt Limit = 2 ppm Cu Limit = 1 ppm

Figure I - Feed vs. Discharge

SECTION V

COMPANY: LAC MINERALS LTD. - Macassa Mine

DETOXIFICATION METHOD: Tailings Pond Overflow

DETOXIFICATION PERIOD: April - June, seasonally

FEED EFFLUENT TYPE: Tailings pond overflow

VOLUME TREATED APRIL/MAY 1991: 594,072 m^3

REAGENT REQUIREMENT:

a) 125 tonnes 100% H_2O_2

b) 42 tonnes dry $CuSO_4.5H_2O$

c) 268 tonnes $Fe_2(SO_4)_3$ (44% solution)

PROCESS DESCRIPTION:

Macassa has a permanent cyanide treatment system that was designed to use hydrogen peroxide. The detox system consisted of four retention tanks. In the first tank the pH was adjusted to greater than 10.5 and copper catalyst and hydrogen peroxide were dosed. The lime and copper were both dosed as a premixed solution. The next two tanks were then used for retention time to ensure the completeness of the oxidation reaction. In the fourth tank ferric sulphate was dosed and mixed. This was done so that when the discharge of tank four went to the polishing pond, metal settlement would occur quickly.

EFFLUENT QUALITY:

Refer to the accompanying graphs.

MACASSA MINE
May 1991 Treatment Data

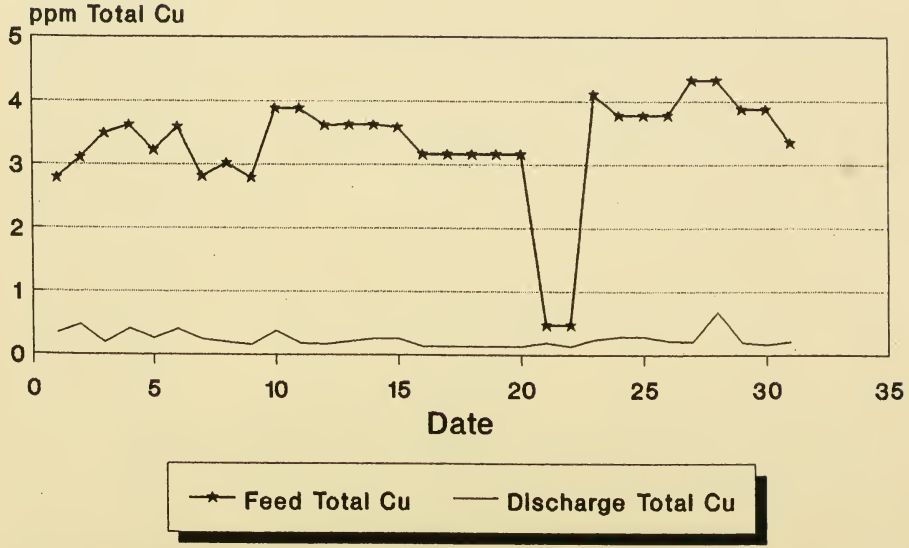


Figure I-Feed vs. Discharge

MACASSA MINE
April 1991 Treatment Data

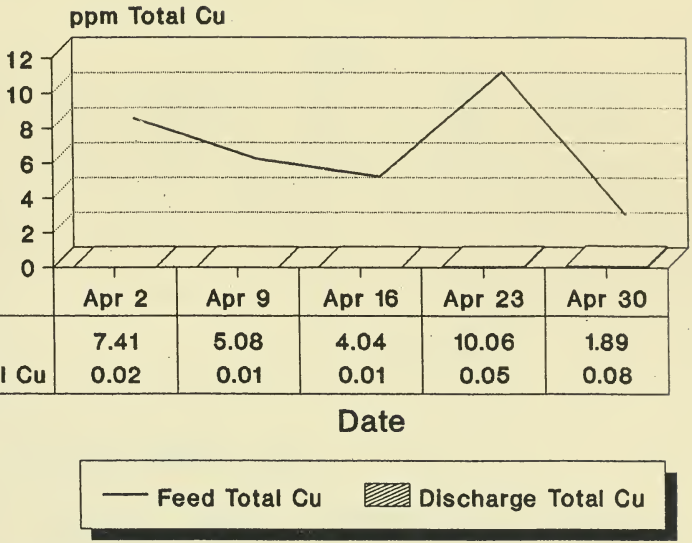


Figure II-Feed vs. Discharge

MACASSA MINE
April 1991 Treatment Data

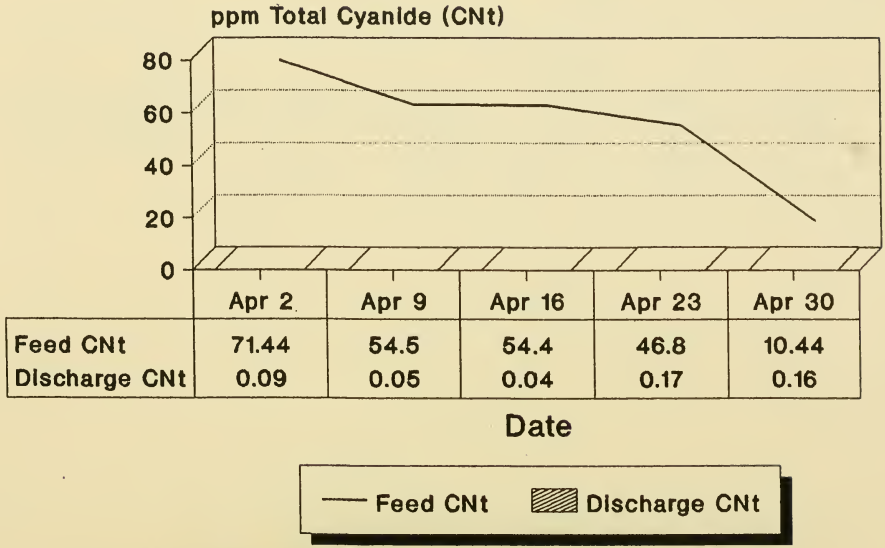


Figure III-Feed vs. Discharge

SECTION VI

COMPANY: LAC MINERALS - East Malartic

DETOXIFICATION METHOD: Emergency pond detoxification

DETOXIFICATION PERIOD: November, 1990 - January, 1991.

FEED EFFLUENT TYPE: Tailings Pond Overflow

VOLUME TREATED/ANNUM: 500 000 m^3

REAGENT REQUIREMENT:

a) 59 tonnes of 100% hydrogen peroxide

b) solid lime

c) Ferric Sulphate solution

PROCESS DESCRIPTION:

East Malartic partially detoxifies their main tailings slurry using SO2/Air before releasing it to the tailings pond. Last summer not all of the residual copper cyanide was naturally degraded resulting in the need for an emergency pond detoxification. In order to perform the detoxification, solid lime was first blown into the tailings pond ahead of the decant tower. to raise the pH to above 10.5. Following this hydrogen peroxide was dosed into the decant tower where the turbulent flow was used for mixing of the H_2O_2 with the effluent. Because the tailings effluent was comprised of mainly copper cyanide, the reaction was almost simultaneous. The discharge from the decant tower flowed into a small containment ditch where ferric sulphate solution was dosed to aid in the settlement of all the metal hydroxides. The flow through the ditch provided for good mixing of the ferric sulphate with the detoxified effluent.

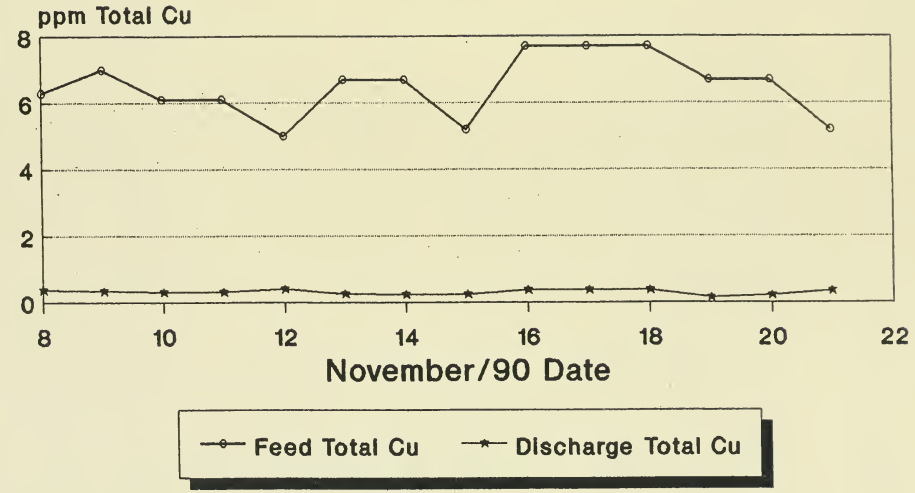
EFFLUENT QUALITY:

Refer to the appended graph

COMMENTS:

The main problem that occurred during this treatment campaign was with the solid lime dosing. This method did not permit total dissolution of the lime sometimes resulting in pH fluctuations. During the dosing some of the lime was prone to settle at the bottom of the pond ahead of the decant tower. This would result in an incomplete reaction. To remedy this East Malartic will attempt to pH adjust their tailings pond prior to a detoxification campaign this season. This detoxification occured while there was ice and snow on both the polishiing pond and the main tailings pond.

EAST MALARTIC MILL
Emergency Detox Data



Total Cu Limit = 0.3 ppm

Figure I - Feed vs. Discharge

SECTION VII a)

COMPANY: CAMBIOR INC. - Yvan Vezina Mine

DETOXIFICATION METHOD: Seasonal Pond Overflow

DETOXIFICATION PERIOD: May - October

FEED EFFLUENT TYPE: Tailings Pond Overflow

VOLUME TREATED JUNE/JULY 1991: 159,630 m3

REAGENT REQUIREMENT:

a) 69 tonnes 100 % H_2O_2

b) Lime slurry

c) 5 ppm Fe^{3+} [44% $Fe(SO_4)_3$ solution]

d) 0.5 ppm Drewfloc 3307

PROCESS DESCRIPTION:

The detoxification plant at the Yvan Vezina Mine is constructed of modular design and is, thus, portable. It consists of five reaction tanks arranged in cascading order. In the first tank The pH is adjusted to greater than 11.5 and hydrogen peroxide is dosed in order to oxidize the cyanide. The first three tanks are used as retention tanks for the oxidation reaction. In tank 4 H_2SO_4 is dosed to lower the pH down to about 10.5 in order to depress the pH closer to the discharge limit of 9.5. It also acts to precipitate any remaining ferrocyanide as a copper-ferrocyanide. In the final tank both ferric sulphate and a non-ionic polymer flocculent are dosed in order to coagulate and precipitate the metal hydroxides in the polishing pond. The effluent is then discharged to the polishing pond where after four days retention it exits to the environment.

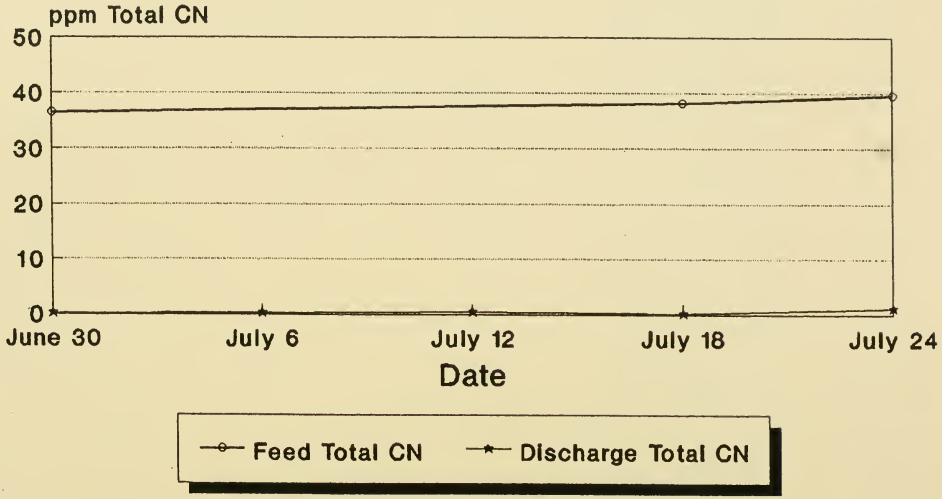
EFFLUENT QUALITY:

Refer to tables I and II for feed and discharge data.

COMMENTS:

For maximum efficiency the pH of the effluent in tanks #4 & #5 is of the utmost importance. Without this control some of the copper hydroxide could redissolve into the effluent causing the polishing pond discharge to be out of compliance. The assays given for the discharge data were taken from the discharge pipe from the detoxification system. At Yvan Vezina the total cyanide levels were always within discharge limits consistently achieving less than 1 ppm. The copper was normally good but fluctuated when problems arose with the pH control. The copper ranged from 0.3 ppm to about 2.5 ppm.

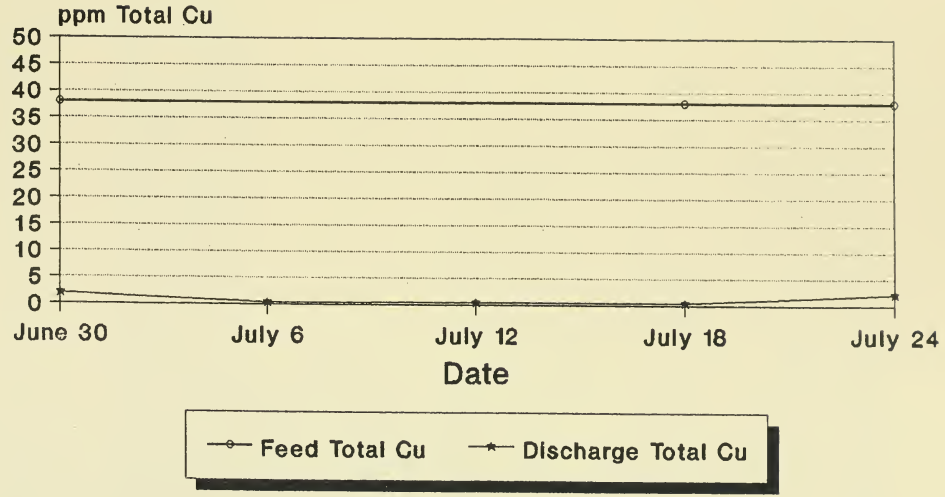
YVAN VEZINA MINE
July Plant Total CN Data



Total CN Limit = 1.5 ppm

Figure I - Feed vs. Discharge

YVAN VEZINA MINE
July Plant Copper Data



Total Cu Limit = 0.3 ppm

Figure II - Feed vs. Discharge

SECTION VII b1)

COMPANY: CAMBIOR INC. - Yvan Vezina Mine

DETOXIFICATION METHOD: Emergency Polishing Pond Detox

DETOXIFICATION PERIOD: September 14, 1990

FEED EFFLUENT TYPE: Polishing Pond Water

VOLUME TREATED/ANNUM: 118,440 m3

REAGENT REQUIREMENT:

a) Solid Lime

b) 6.2 tonnes 100% H_2O_2

PROCESS DESCRIPTION:

Initially Yvan Vezina Mine requested that Degussa treat their polishing pond with hydrogen peroxide in order to prove the effectiveness of this treatment method. Hydrogen peroxide was dosed at three locations in the polishing pond. This was done by towing the H_2O_2 dosage hose using a motor boat. The total time taken to dose the peroxide was 2.5 hours, during which time the hydrogen peroxide was allowed to oxidize the cyanide.

EFFLUENT QUALITY:

Refer to Table I & II for the before and after Total cyanide concentrations.

COMMENTS:

What is unique about this detoxification is that an overflow was not treated, but rather a stagnant body of effluent. This meant that very little if any mixing was available, yet the oxidation

reaction still was able to occur. Before the hydrogen peroxide addition the total cyanide assayed 6 ppm and the copper assayed 4 ppm. Following the addition of the peroxide the total cyanide assayed ‹0.5 ppm and the copper assayed 0.3 - 0.4 ppm. In treating this polishing pond, we were then able to proceed with the emergency treatment of the main tailings pond. This is outlined in section VII b2.

SECTION VII b2

COMPANY: CAMBIOR INC. - Yvan Vezina Mine

DETOXIFICATION METHOD: Emergency Tailings Pond Overflow

DETOXIFICATION PERIOD: October 1990

FEED EFFLUENT TYPE: Tailings Pond Overflow

VOLUME TREATED/ANNUM: 482,206 m3

REAGENT REQUIREMENT:

a) Lime Slurry

b) 52 tonnes 100% H_2O_2

PROCESS DESCRIPTION:

Hydrogen peroxide and lime slurry were simultaneously dosed into the main tailings pond decant tower. The turbulent flow through the tower provided for the mixing of the peroxide and the lime. The discharge from the culvert flowed into the polishing pond where the metals were allowed to settle.

EFFLUENT QUALITY:

Refer to Table I for the total cyanide concentrations before and after the hydrogen peroxide treatment. The table illustrates how the total cyanide fluctuates during the first three days following the peroxide addition, and how after the three days the oxidation reaction is finally complete with total cyanide values being below 1 ppm consistently.

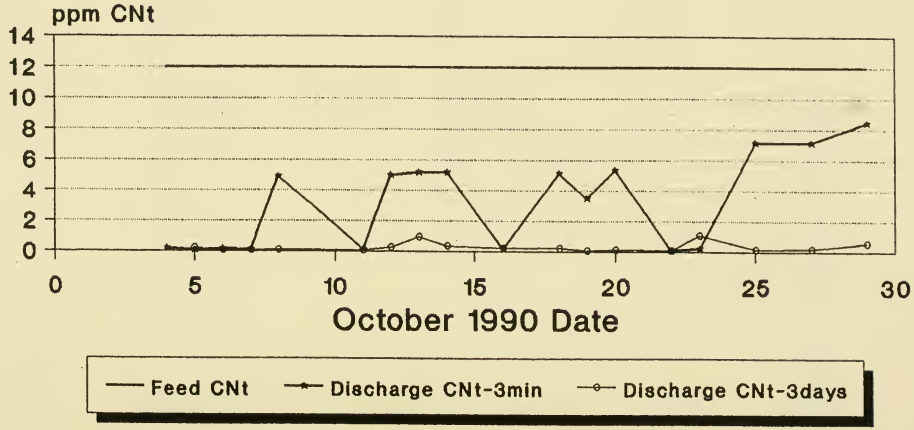
COMMENTS:

Suspended copper clarification did pose a problem during the treatment campaign. This can be accounted for by a lack of a coagulant or a flocculant used during the treatment.

YVAN VEZINA MINE

Emergency Pond Detox Data

Total Cyanide



CNt Limit = 1.5 ppm

Figure I

SECTION VIII

COMPANY: GRANGES EXPLORATION LTD. - Tartan Lake Mine

DETOXIFICATION METHOD: Batch Detoxification

DETOXIFICATION PERIOD: Year Round

FEED EFFLUENT TYPE: Barren Solution

VOLUME TREATED/ANNUM: 5000 - 6000 m3

REAGENT REQUIREMENT:

a) 50 - 100 tonnes 100% H_2O_2 / annum

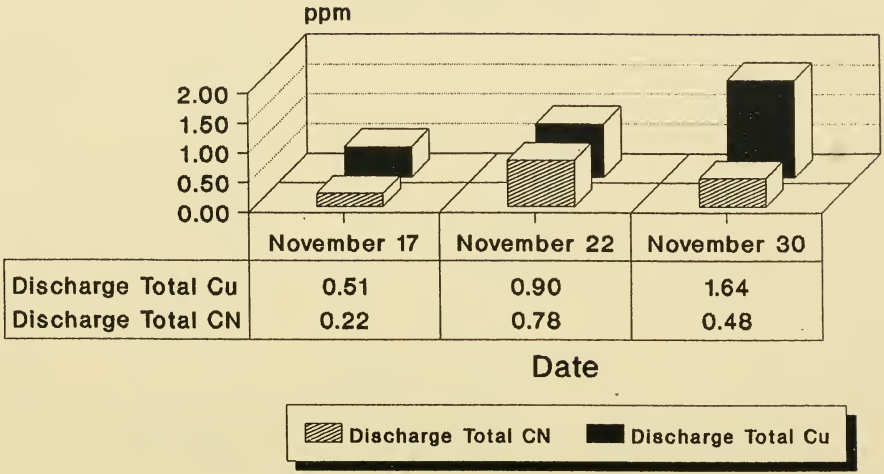
PROCESS DESCRIPTION:

Tartan Lake had a permanent cyanide detoxification tank. This tank could batch treat about 4 m3 of barren solution daily. The tank was square and was baffled for mixing. The hydrogen peroxide was dosed via a barrel pump from a drum to the detoxification circuit. A change in barren colour from clear to green symbolized the completion of the detoxification. Detoxified effluent was discharged to the tailings pond. The detoxification cycle would resume and repeat itself 4 times daily.

EFFLUENT QUALITY:

Refer to the accompanying graph for information on the discharge from the tailings line.

TARTAN LAKE MINE
November 1988 Discharge Data



Feed CNt=414 ppm Feed Cut= 157 ppm

Figure I

SECTION IX

COMPANY: PIONEER METALS CORP. - Puffy Lake Mine

DETOXIFICATION METHOD: Continuous Flow

DETOXIFICATION PERIOD: Year - Round

FEED EFFLUENT TYPE: Barren Solution

VOLUME TREATED/ANNUM: 26,280 m3

REAGENT REQUIREMENT:

a) 314 tonnes 100% H_2O_2

PROCESS DESCRIPTION:

The detoxification system consisted of two 8 m3 reaction tanks. Both tanks had pH control and the first tank was ORP controlled. The hydrogen peroxide was dosed into the first tank without any other chemical additions. From here the detoxified material was pumped along with the float tails, and the washed leach tails into the tailings disposal area. The pond was discharged during spring run-off. The supernatant from the disposal area is pumped back to the mill for re-use in the process

EFFLUENT QUALITY:

No effluent data was available for this operation since it ceased production in the winter of 1989.

pH Adjustment Using

Carbon Dioxide

Appendix 5

of the

Development Document

Carbon Dioxide

- Produced from By-Product Streams:
  - ammonia
  - fermentation
  - petrochemical

- Physical Properties:
  - gas temperature = 15°C and pressure = 1 atmosphere
  - colourless, odourless, non-flammable
  - tastes slightly acid

- CO2 Applications:
  - freezing and chilling
  - carbonation
  - welding
  - purging and inerting
  - blow molding
  - foamed plastics
  - cryogenic grinding
  - atmosphere control
  - industrial cleaning
  - super critical CO_2
  - fumigation
  - pH control

- Carbon Dioxide Advantages:
  - ensures a maximum life-span for equipment and pipe system
  - reliable in its regulation process
  - safe to use
  - environmental preserving
  - economical

- Bulk Supply:
  - 3 to 50 ton capacity
  - 300 psi at 0°F
  - refrigeration system: 240/480V, 3PH, 60HZ
  - vaporiser: 240/480V, 3PH, 60HZ

Carbon Dioxide Chemical Properties:

- when dissolved in water it forms a weak acid

$$H_2O + CO_2 = H_2CO_3$$

- this dissociates weakly

$$H_2CO_3 = H^+ + HCO_3^-$$

- reacts with alkali

$$2\ NaOH + CO_2 = Na_2CO_3 + H_2O$$

$$Na_2CO_3 + H_2O + CO_2 = 2NaHCO_3$$

- solubility in water at pressure 1 atmosphere

0°C	3.39 g/l
10	2.35
20	1.72
25	1.50

at saturation at 25°C pH = 3.8

- To lower pH CO_2 consumption depends on:
  - alkalinity or water to be treated
  - initial and final pH values

Design Considerations: Method of Injection

- Direct Injection:
  - 20 - 30 seconds retention time
  - velocity of 4 - 8 feet/second

- Basin Injection
  - 30 seconds retention time
  - 8 ft. - 10 ft. depth

Advantages of Carbon Dioxide

The three major benefits of using CO_2 in lieu of a strong mineral acid (such as sulfuric) for reducing the pH in waste water:

Safety: CO_2, in its pure state is an inert, non corrosive gas, making it easier and much safer to handle. The risk of personal injury, the associated hazards and necessary precautions in the event of an accidental spill, are virtually eliminated.

Better Process Control: The use of carbonic acid (formed when the CO_2 gas dissolves in water), a mild acid compared to mineral acids, has successfully been demonstrated to minimize overshoot and rapidly respond to any upset of either incoming pH or waste water flow rate.

Economics: The use of CO_2 proved to be more cost effective than mineral acids.CO_2 eliminates acid spill clean-up cost, eliminates injuries, equipment maintenance... It is also proven that one kilogram of CO_2 is more effective than one kilogram of sulfuric acid. In addition the cost of CO_2 is less than that of sulfuric acid.

Additional benefits can also be attested to, including:

Reliability: With a minimum number of moving parts, CO_2 control system has been engineered to offer consistent, trouble free operation. The prime moving force of the CO_2 gas is pressure, not an articulated pump which may fail. Furthermore, maintenance and repairs to the piping and control system is minimized as CO_2 gas is NOT corrosive.

Flexibility: The turn-down ratio on the injection rate of CO_2 is at least 10 to 1, making the CO_2 pH Control System extremely flexible to operate over a wide range.

Maintenance Free Operation: In the unlikely event of a problem with the CO_2 storage system, bulk Installation mechanics/Technicians can be rapidly dispatched to the site on a round-the-clock basis.

MINING

COPPER, ZINC MINE- ONTARIO

APPLICATION : EFFLUENT FROM LAGOON

INITIAL PH : 11.0 DESIRED PH : 8.0

STREAM FLOW : 440 USGPM

CO2 SYSTEM : DIRECT INJECTION INTO A 8" DIA PIPE

DRIVING FORCE : CO_2 ECONOMICS vs H_2SO_4
PH CONTROL STABILITY

CHEMICAL PROCESSOR

ONTARIO

APPLICATION : RECIRCULATION STREAM

INITIAL PH : 9.5 DESIRED PH : 7.0

STREAM FLOW : 35 USGPM

CO2 SYSTEM : DIRECT INJECTION INTO A 1.5"DIA PIPE

DRIVING FORCE : ENVIRONMENTALLY FRIENDLY
PH CONTROL STABILITY

QUARRY

LIME AND AGGREGATES - ONTARIO

APPLICATION : EFFLUENT

INITIAL PH : 11.5 DESIRED PH : 8.5

STREAM FLOW : 1000 USGPM

CO2 SYSTEM : DIRECT INJECTION INTO A 8" DIA PIPE

DRIVING FORCE : CO_2 ECONOMICS vs H_2SO_4
PH CONTROL STABILITY

BREWING INDUSTRY

ONTARIO

APPLICATION : EFFLUENT

INITIAL PH : 12.0 DESIRED PH : 8.5

STREAM FLOW : 1100 USGPM

CO2 SYSTEM : SIDE STEAM INJECTION, 8" DIA PIPE

DRIVING FORCE : ENVIRONMENTALLY FRIENDLY
PH CONTROL STABILITY

FOOD PROCESSING PLANT

ONTARIO

APPLICATION : EFFLUENT

INITIAL PH : 13.0 DESIRED PH : 8.5

STREAM FLOW : 550 USGPM

CO2 SYSTEM : DIRECT INJECTION INTO A 6" DIA PIPE

DRIVING FORCE : SAFETY
PH CONTROL STABILITY

PULP AND PAPER

DEINKING PLANT - ONTARIO

3 LOCATIONS

APPLICATION : PULP SLURRY AT 1.5% SOLIDS

INITIAL PH : 11.5 DESIRED PH : 7.0

STREAM FLOW : 730 USGPM

CO2 SYSTEM : DIRECT INJECTION INTO A 8" DIA PIPE

DRIVING FORCE : CO_2 ECONOMICS vs H_2SO_4
PH CONTROL STABILITY

CARBON DIOXIDE

SPECIFICATION

The following Compressed Gas Association Grade of carbon dioxide in both cylinder and bulk liquid form is available as a standard at all Liquid Air locations.

C.G.A. Grade	A
Types	I & II
Carbon dioxide, minimum (v/v)	99.5%*
Water (v/v)	120 ppm
Dew point	−40°C
Volatile hydrocarbons (as Methane)	20 ppm
Non-volatile residues (w/w)	10 ppm
U.S. Pharmacopeia	Yes

*Liquid Air, CO_2 is maintained at 99.9% with less than 0.1% inerts and is CO, oil, taste and odor free.

AVAILABILITY

Gaseous carbon dioxide, Type I, is available in standard high pressure cylinders, at a vapor pressure of 4990 kPa and 15°C, of the following capacities:

Nominal Water Content	Industrial Weights	Medical Weights/volumes at 15°C and 101.325 kPa (abs)	
37 L	22.68 kg	22.68 kg	12.11 m³
14 L	9.07 kg	9.07 kg	4.84 m³
5 L	—	2.72 kg	1.45 m³
3 L	—	1.81 kg	967 L

Liquid carbon dioxide, Type II is available in:
(A) Liquid cylinder delivering gas at up to 2010 kPa of 174 kg (93 m³) capacity,
(B) Bulk gas in standard refrigeration recovery systems operating at 2070 kPa and of a storage capacity ranging from 2.7 to 28 tonnes.

PHYSICAL CONSTANTS

Chemical symbol	CO_2
Molecular weight	44.010 g/mole
Density at 0°C and 101.325 kPa (abs)	1.977 kg/m³
Density at 15°C and 101.325 kPa (abs)	1.872 270 kg/m³
Specific gravity at 0°C and 101.325 kPa (abs) (air = 1)	1.529
Specific volume at 15°C and 101.325 kPa (abs)	0.534 11 m³/kg
Triple point — temperature	−56.57°C
— pressure	518.5 kPa (abs)
— latent heat of fusion	196.5 kJ/kg
Sublimation point — temperature	−78.5°C
— pressure	101.325 kPa (abs)
— latent heat	570.70 kJ/kg
— solid density	1562 kg/m³
— gas density	2.814 kg/m³
Critical point — temperature	31.06°C
— pressure	7382.5 kPa (abs)
— density	464 kg/m³
1 kg of solid at the sublimation point when allowed to expand to 15°C and 100 kPa (abs) liberates	541 L of gas
c_p at 0°C and 100 kPa (abs)	0.825 kJ/(kg.K)
c_v at 0°C and 100 kPa (abs)	0.631 kJ/(kg.K)
Solubility in water at 15°C (Bunsen coef.)	1.0107 (v/v)

PROPERTIES

Under normal conditions, carbon dioxide is a non-flammable, colorless, odorless gas, that is practically tasteless, although when inhaled it produces a choking sensation.

Carbon dioxide is relatively inert, asphyxiating, and at atmospheric conditions about fifty percent heavier than air. It is toxic in high concentrations only.

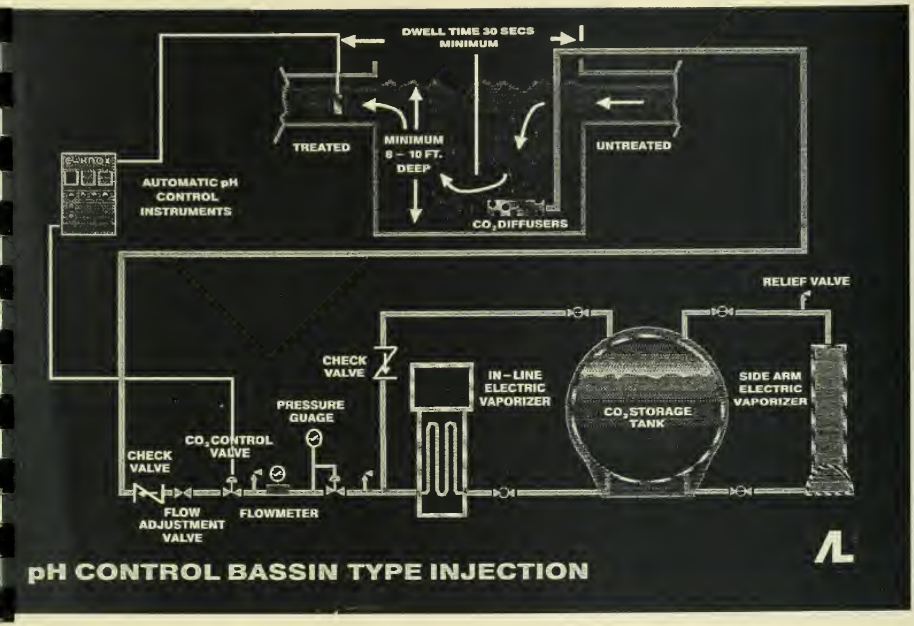
Carbon dioxide readily dissolves in water. At atmospheric pressure and a temperature of 15°C, a given volume of water will dissolve an equal volume of carbon dioxide.

At greater pressures more carbon dioxide can be dissolved, but as soon as the pressure is released, it comes out of solution. This is what causes the effervescence when a soft drink is uncapped.

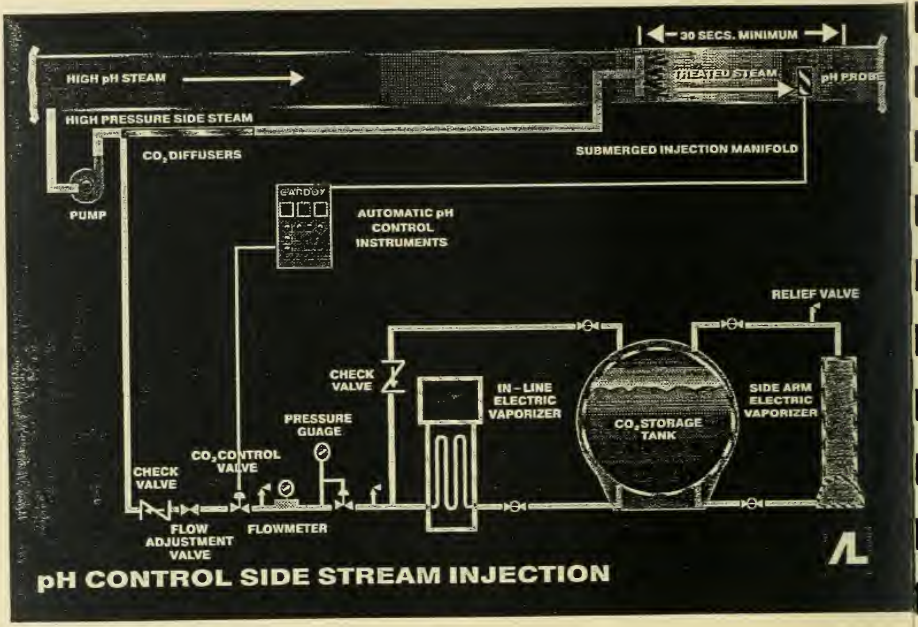
Carbon dioxide exists simultaneously as a solid, liquid and gas at a temperature of −56.57°C and a pressure of 518.5 kPa (abs), its triple point. At temperatures and pressures below the triple point, carbon dioxide forms carbonic acid (H_2CO_3) which gas depending on conditions. Solid carbon dioxide at a temperature of −78.5°C and atmospheric pressure transforms directly to a gas (sublimes) without passing through the liquid phase.

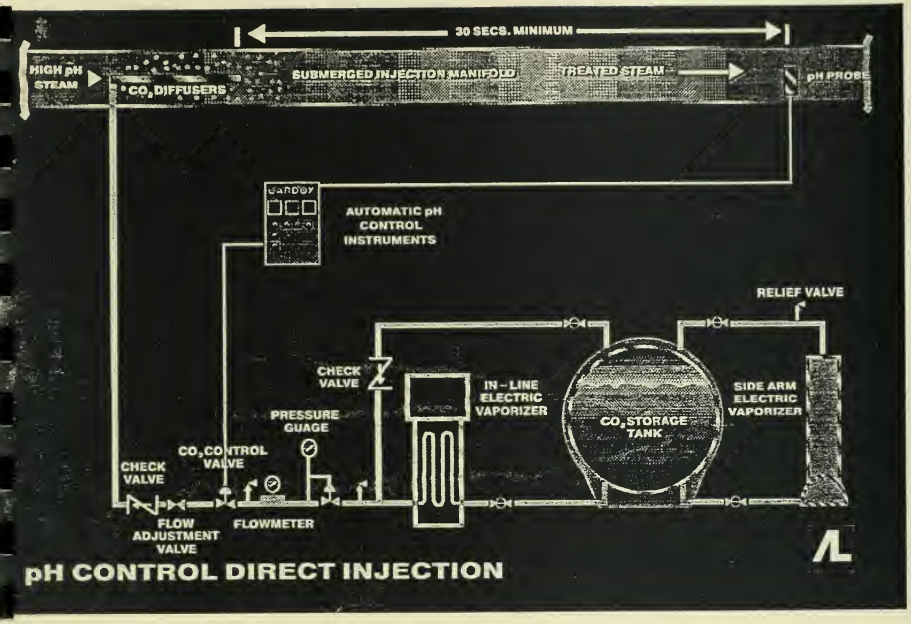
At temperatures and pressures above the triple point and below the critical temperature of 31.06°C, carbon dioxide liquid and gas may exist in equilibrium in a closed container. Above 31.06°C, carbon dioxide cannot exist as a liquid regardless of pressure.

Under most normal conditions, carbon dioxide is stable, but at extremely high temperatures (above 650°C) it partially dissociates into carbon monoxide and oxygen. When dissolved in water, carbon dioxide forms carbonic acid (H_2CO_3) which is weak and unstable and tends to revert back to carbon dioxide and water.



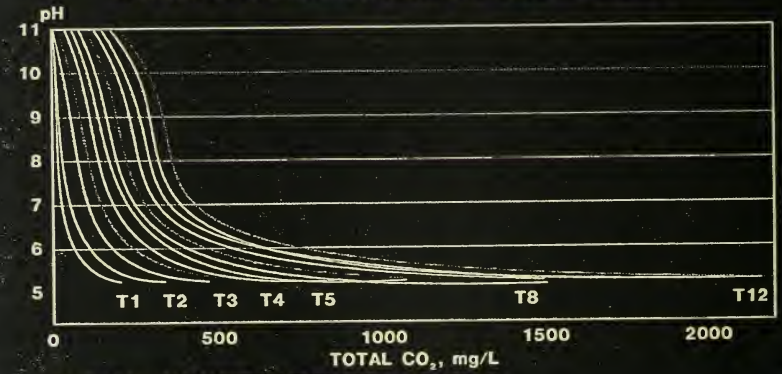
pH CONTROL BASSIN TYPE INJECTION


30 SECS. MINIMUM
HIGH pH STEAM
TREATED STEAM
pH PROBE
HIGH PRESSURE SIDE STEAM
CO_2 DIFFUSERS
SUBMERGED INJECTION MANIFOLD
PUMP
AUTOMATIC pH CONTROL INSTRUMENTS
RELIEF VALVE
CHECK VALVE
IN-LINE ELECTRIC VAPORIZER
CO_2 STORAGE TANK
SIDE ARM ELECTRIC VAPORIZER
PRESSURE GUAGE
CO_2 CONTROL VALVE
CHECK VALVE
FLOW ADJUSTMENT VALVE
FLOWMETER
pH CONTROL SIDE STREAM INJECTION


30 SECS. MINIMUM
HIGH pH STEAM
CO_2 DIFFUSERS
SUBMERGED INJECTION MANIFOLD
TREATED STEAM
pH PROBE
AUTOMATIC pH CONTROL INSTRUMENTS
RELIEF VALVE
CHECK VALVE
IN-LINE ELECTRIC VAPORIZER
CO_2 STORAGE TANK
SIDE ARM ELECTRIC VAPORIZER
PRESSURE GUAGE
CO_2 CONTROL VALVE
CHECK VALVE
FLOW ADJUSTMENT VALVE
FLOWMETER
pH CONTROL DIRECT INJECTION

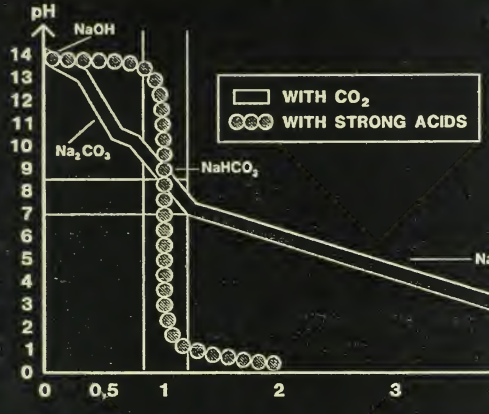
TOTAL CO_2 vs pH (at 25°C)

FOR WATER AT DIFFERENT LEVELS OF TOTAL ALKALINITY



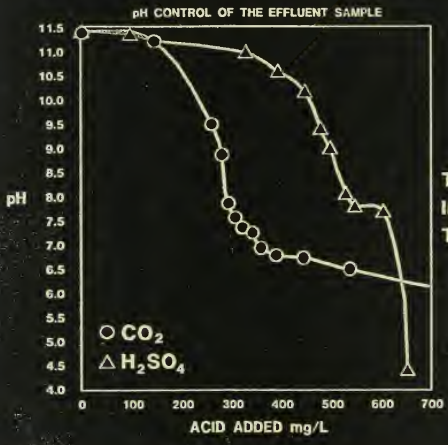
Tx: TOTAL ALKALINITY LEVEL, AS mg $CaCO_3$/L
(T1=25, T2=50, T3=75,...T12=300 mg $CaCO_3$/L)

NEUTRALISATION CURVE OF AN ALKALINE SOLUTION OF SODA (1 N)



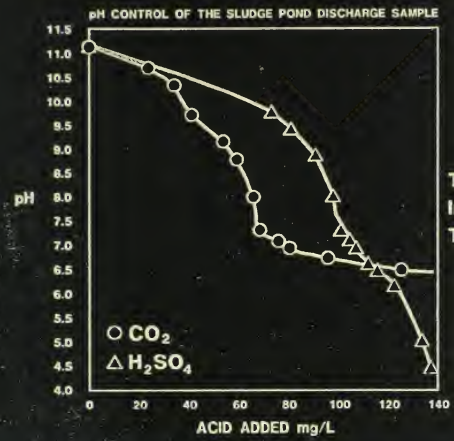
- The smallest shortage or excess of strong acids will cause pH values to largely exceed the limits of the required neutral zone. On the contrary, CO_2, will withstand large dosage variations.

CARBON DIOXIDE
NEUTRALISATION CURVES FOR MINE EFFLUENT



Temperature: 30°C (86°F)
Initial pH: 9.8
Total Alkalinity: 666.7 mg $CaCO_3$/L

CARBON DIOXIDE
NEUTRALISATION CURVES FOR MINE EFFLUENT



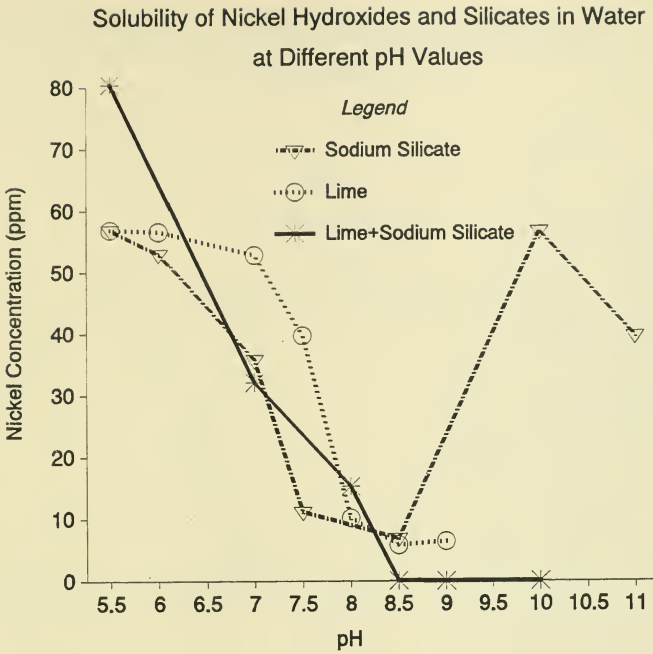
Temperature: 25°C (77°F)
Initial pH: 9.1
Total Alkalinity: 140 mg $CaCO_3$/L

Metals Control Using Water Soluble Silicates

Appendix 6

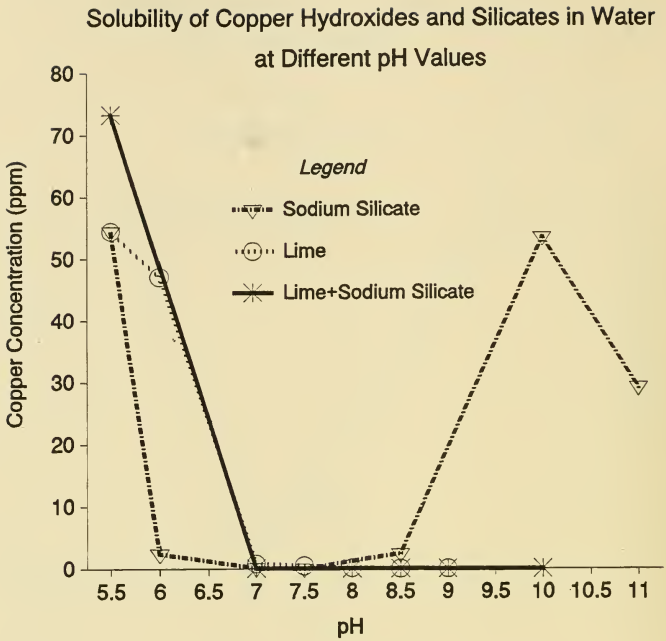
of the

Development Document



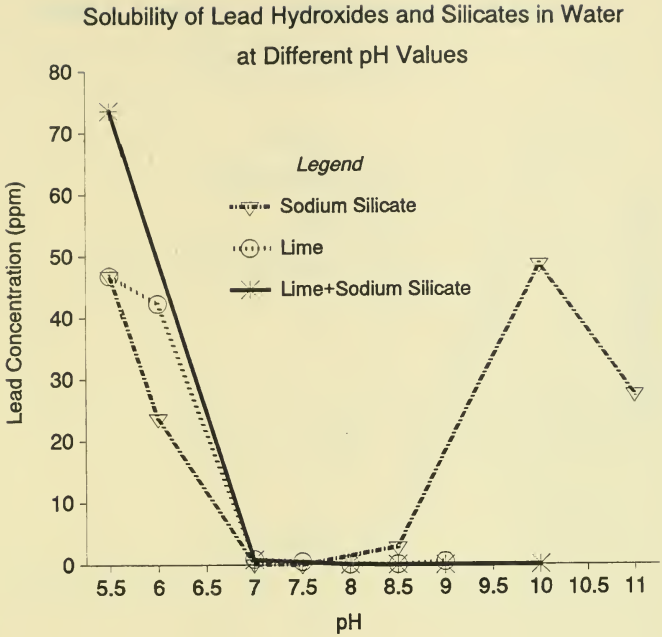
Data Table: Solubility of Nickel Hydroxides and Silicates in Water at Different pH Values

	ppm Nickel		
pH	Sodium Silicate	Lime	Sodium Silicate + Lime
5.5	56.90	56.90	80.400
6.0	53.00	56.60	
7.0	35.80	52.80	32.100
7.5	11.20	39.70	
8.0		10.20	15.300
8.5	6.93	5.85	0.115
9.0		6.44	0.062
10.0	56.70		0.039
11.0	39.70		



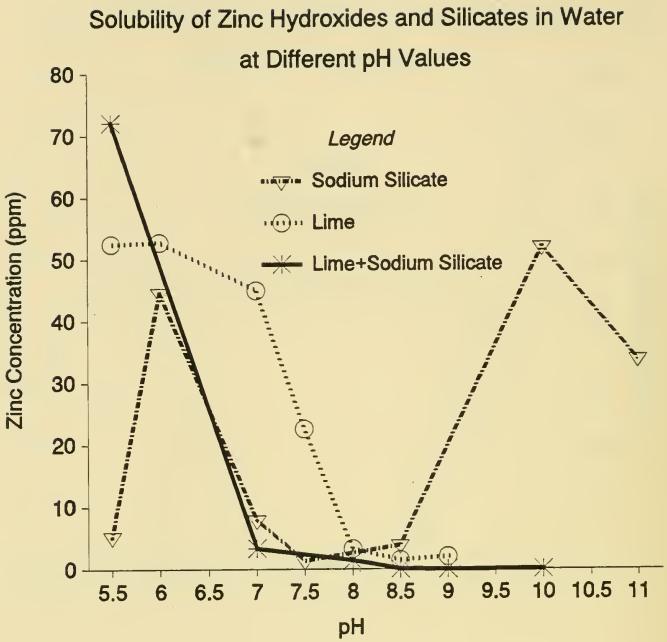
Data Table: Solubility of Copper Hydroxides and Silicates in Water at Different pH Values

	ppm Copper		
pH	Sodium Silicate	Lime	Sodium Silicate + Lime
5.5	54.500	54.5000	73.300
6.0	2.450	47.1000	
7.0	0.126	0.8160	0.098
7.5	0.030	0.4800	
8.0		0.1480	0.049
8.5	2.460	0.0680	0.051
9.0		0.0699	0.022
10.0	53.500		0.030
11.0	29.200		



Data Table: Solubility of Lead Hydroxides and Silicates in Water at Different pH Values

	ppm Lead		
pH	Sodium Silicate	Lime	Sodium Silicate + Lime
5.5	46.800	46.800	73.600
6.0	23.700	42.300	
7.0	0.134	0.926	0.830
7.5	0.010	0.511	
8.0		0.115	0.070
8.5	2.890	0.098	0.021
9.0		0.534	0.010
10.0	48.600		0.015
11.0	27.500		



Data Table: Solubility of Zinc Hydroxides and Silicates in Water at Different pH Values

	ppm Zinc		
pH	Sodium Silicate	Lime	Sodium Silicate + Lime
5.5	52.50	52.50	72.100
6.0	44.60	52.80	
7.0	7.90	45.00	3.340
7.5	1.35	22.60	
8.0		3.29	1.420
8.5	3.91	1.48	0.050
9.0		2.04	0.035
10.0	52.00		0.040
11.0	33.80		

National Silicates Limited

429 Kipling Avenue

Toronto, Ontario

M8V 3S7

SOLUBILITY OF METAL SILICATES AND THEIR REMOVAL EFFICIENCY IN WASTEWATER SYSTEMS - LABORATORY STUDY

January 1993

THE SOLUBILITY OF METAL SILICATES AND THEIR REMOVAL EFFICIENCY FROM WASTEWATER SYSTEMS - LABORATORY STUDY.

INTRODUCTION.

The objective of the investigation described in this report was to determine a unique application for sodium or potassium silicates in wastewater treatment.
Recent studies performed by J. S. Falcon and K. A. Blackburn (PQ report No. 76-80) have shown that silicates interact with heavy metal ions, forming insoluble metal silicates.
Preliminary tests discussed in this report were designed to screen various methodologies for heavy metal removal as well as to determine the solubility of different metal silicates over a pH range of 6.0 - 9.5.
Currently, the pH range for effective removal of heavy metals is between 9.5 - 11.0.

SUMMARY.

This report demonstrates the alternative silicate technology used to form the most stable heavy metal precipitates as well as to improve the removal efficiency of various metals (Ni, Zn, Pb, Cu) from wastewater.
Metals were also precipitated with lime, which is the commonly used chemical in the treatment of mining wastewater.

The removal of metal ions can best be expressed by an inverse relationship between solubility of the metal and it's precipitate, for example: high solubility results in low precipitation, whilst low solubility is a reflection of efficient metal removal.
The following conclusions have been drawn from the results of the studies presented in this report.

1. Of all four metals investigated, the most difficult to precipitate and remove at all pH values was **nickel** (all treatments).
   Nickel precipitates show the lowest solubility at pH = 8.5 (0.115 ppm Ni) when treated with a mixture of lime and silicate. Nickel was also effectively precipitated with sodium silicate only at pH = 7.5 (11.20 ppm Ni).

2. **Zinc** precipitates formed as a results of lime/silicate treatment were least soluble at pH = 9.0 (0.035 ppm Zn).

3. **Lead** content in treated water was lowest at ph = 9.0 when a lime/silicate treatment was applied.
   Sodium silicate treatment of lead showed good results

at a pH as low as 7.5 (0.01ppm Pb).

4. **Copper** was effectively removed at pH = 9.0 when treated with lime/silicate. Copper could be also precipitated at pH = 7.5 when only sodium silicate was applied (0.03 ppm Cu).

RECOMMENDATIONS.

1. Based on the metal silicates solubility and removal efficiency the following recommendation can be made.

   a) The optimum pH range was determined to be 7.5 - 9.5.

   b) The most efficient treatment was the combination of lime and sodium silicate.

EXPERIMENTAL PROCEDURES.

The following text provides the detailed experimental procedure for precipitation, stability and removal of nickel, zinc, lead, and copper sediments, from the synthetic wastewater solution employed in the studies.

1. The synthetic wastewater (stock solution) was prepared, containing approximately 50 -80 ppm of each metal (see the tables 1,2,3,4 for exact levels).
   Deionized water was used for all experiments.
   Analytical BDH reagents (metal salts) were used for artificial water contamination: $Ni(NO_3)_2x6H_2O$, $ZnCl_2$, $Pb(NO_3)_2$, $Cu(NO_3)_2x3H_2O$.

2. The following standard solutions of treating chemicals were used:
   a) lime(1% solution)
   b) liquid sodium silicate

Each sample of 100 ml of the stock solution, containing all four metals was adjusted to a desired pH by adding separately appropriate amount of each chemical: lime or sodium silicate , or lime/sodium silicate mixture. pH was measured immediately after it stabilized (3 decimal places). Every sample was left then for 10 days and pH was measured every other day. Samples were filtered through paper filter (42 analytical grade) and solutions were analyzed for metal content.

DISCUSSION.

NICKEL was the most difficult metal to precipitate and remove. It indicates, that lime/sodium silicate mixture at pH = 7.0, resulted in a nickel content reduction of 60.1%. At pH = 9.0, the mixture lime/silicate was superior to others ,giving a 99.92% removal efficiency.
Lime best performance occurred at pH = 8.5 (89.7% removal

efficiency).

ZINC precipitated most efficiently at pH = 7.0, when treated with the mixture of lime/silicate resulting in removal efficiency of 60.1%. for the same treatment at a higher pH (9.0), the removal efficiency reached 99.92%.
Lime precipitation at pH = 8.5 resulted in 89.7% removal efficiency.

LEAD concentration reached its minimum at pH = 9.0 when treated with the combination of lime and silicate.

COPPER lowest concentration was achieved at pH = 6.0 when sodium silicate treatment was applied resulting in 95.5% removal efficiency.
Lime/silicate combination precipitated copper at pH = 9.0 resulting in 99.97% reduction of the original copper concentration.

CONCLUSIONS.

According the above results the best working system, giving the lowest solubility and the highest removal efficiency values occurred over a pH range 6.0 - 9.5 with the mixture of lime and sodium silicate.
Depending on the treatment (reagent used), the optimum working pH range has been determined;

	pH ranges			
REAGENT/METAL	**Ni**	**Zn**	**Pb**	**Cu**
Lime/silicate	**8.0-10.0**	**8.0-9.0**	**7.0-9.0**	**7.0-9.0**
sodium silicate	**7.5-9.0**	**7.0-8.5**	**6.5-8.0**	**6.0-8.0**
Lime	**8.0-10.0**	**8.0-9.0**	**7.0-9.0**	**7.0-9.0**

The Vitrokele Process

Appendix 7

of the

Development Document

CYANIDE RECOVERY AND COPPER REMOVAL FROM GOLD PLANT EFFLUENTS USING VITROKELE™ - PILOT PLANT RESULTS

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Perth, 6017
Western Australia

D. Kidby
Jasmetech Metal Technologies
110 Leacock Road
Pointe Claire, Quebec H9R 1H1

Vitrokele™ is a synthetic adsorbent, using chelating groups on large polystyrene beads, developed in Canada over 7 years ago, and first commercialised in 1985 to recover noxious metals from plating wastes.

Pilot plant trials have been performed in Australia and Canada to demonstrate the recovery of cyanide and removal of metal cyanide complexes from gold plant effluent using Vitrokele™ 912. The pilot plants comprise a simple adsorption train (similar to a CIP circuit) followed by complete elution facilities, so that loaded Vitrokele™ can be stripped and returned to the adsorption circuit.

An account of these campaigns is provided, showing the reduction of total CN levels from over 200ppm to less than 0.5ppm and Cu levels from approximately 100ppm to less than 0.3ppm in treated tailings.

Comparisons between pilot plant results and laboratory test data are given and probable future work on the process and its application to the gold mining industry is discussed.

INTRODUCTION

Through millions of years of evolution, life forms have developed specialised molecules with exceptionally high affinity and selectivity for various metals such as iron, cobalt, zinc and copper.

In the early 80's professors at the Faculty of Medicine of McGill University engaged in research on the extremely efficient ways that living cells captured trace metals essential for life.

As research progressed, it became evident that the special molecules used by biological systems to capture metals could be synthesized to capture selected metals with similar efficiency from water or other solutions.

The technology was first commercialised in 1985 to recover noxious metals from plating wastes with compositions applying the special molecules (chelating groups) on vitreous particles (hence Vitrokele™). To date three commercial Vitrokele™ plants have been installed for treating plating waters in Ontario and Quebec.

Over thirty types of Vitrokele™ have been synthesized. One of particular interest to the gold industry is V912 which is specific for metal cyanide complexes. Because Vitrokele™ adsorbents function primarily by chelating type adsorption of metals, they provide significant metal selectivity, are relatively transparent to non-target ions (Ca, Mg, Na etc) and can provide extremely low residual metal levels in treated waste water.

Early laboratory test work programmes conducted in Australia were designed to demonstrate the unique adsorption characteristics of V912 when applied to the recovery of reusable cyanide and the scavenging of metals from the tailings streams of CIP and CIL plants. Upon completion of the adsorption tests, V912 was eluted chemically at ambient temperature.

These test campaigns also provided data for flowsheet selection and design of a plant for piloting of the technology on a larger scale at an Australasian gold mine. Designed to handle 10m³/day of tailings slurry, this pilot plant ran at Gabanintha mine (West Australia) for 3 test campaigns during 1989, and was subsequently moved to Cosmo Howley mine (Northern Territory) for further trials during 1990.

Results of these campaigns are presented below. They were very encouraging and indicated that it was possible to develop an effective flowsheet and plant to recover cyanide from tailings pulp and reduce environmentally significant metals to acceptable concentrations. The Vitrokele™ In-Pulp (VIP) flowsheet was further refined on the basis of this work and a second pilot plant constructed in Guelph, Ontario in late 1990.

This second pilot plant included a 5 stage adsorption circuit for the removal of cyanide and heavy metals from tailings pulp at a design through-put of 10m³/day. Full elution facilities were provided for the recovery of cyanide, removal of metals and recycle of eluants, with regenerated Vitrokele™ being continuously returned to the adsorption circuit. Counter-current transfer of Vitrokele™ was performed on a continuous basis using pumps. The pilot plant thus represents a scaled down version of the entire process.

The plant has operated at two Canadian gold mines (this paper describes the results obtained during the first campaigns) and is now operating in Nevada, USA.

LABORATORY TESTWORK

Since commencement of laboratory work on Vitrokele™ in Australia, tailings slurries from over 27 precious metal mines have been tested, including:

- gold oxide ore;
- copper-gold; oxide-sulphide ores;
- base metal ores;
- flotation concentrates.

The laboratory test programs were designed to demonstrate the economic recovery of cyanide and precious metals using V912. Producing a detoxified tailing was not a specific objective of the Australian testwork at that time.

Of 11 ore types for which CN and/or Cu data were available, the residual tenors were reduced to under 0.5ppm titratable CN and/or 0.5ppm Cu in 8 cases (the testwork did not explore this limit, the focus being on kinetics and V912 loading).

The CN and Cu extraction performance was often better than:

- 99.9% recoveries in batch tests 3 - 24 hrs residence time, 10g V912 per litre), and
- 75% recovery/stage (2 hour residence time, 35g V912/litre) in continuous throughflow.

For cyanide, the best result was a reduction of 563ppm CN to an undetectable level (<0.1ppm). For copper, the best batch result reduced 621ppm Cu to 0.45ppm (apart from tests showing residual Cu below the detection limit of the analysis employed).

Typical results from a batch adsorption test are shown in Table 1.

TABLE 1
TYPICAL BATCH ADSORPTION TEST

SPECIES	FEED SLURRY (ppm)	TREATED SLURRY (ppm)
Au	0.91	<0.01
Ag	0.85	<0.01
Cu	621	0.75
Zn	9.07	0.10
Fe	10.75	0.30
Cd	0.12	<0.01
Ni	0.38	0.04
CN_{TOTAL}	1058	0.30

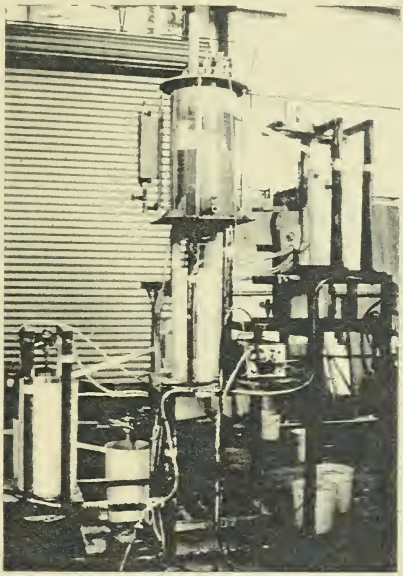
A long term cyclic test involving 147 cycles of adsorption and elution was performed in highly abrasive pulp to test the abrasion resistance of Vitrokele™. Over the test, 8% by volume and 2% by weight of the V912 was lost. Loading kinetics showed a gradual decline but the adsorbent was still effectively loading both copper and gold at conclusion of the tests.

The test demonstrated the excellent physical durability of V912 and its capacity to retain loading and elution kinetics in a complex solution after multiple use.

Currently, laboratory work is carried out by Jasmetech in Canada and Signet in Australia on various ore samples as a prelude to on-site testwork and possible piloting.

Figure 1 shows a V912 laboratory adsorption test rig comprising 3 CIL and 5 VIP contactors each with a pulp residence time of 1 hour/stage. V912 elutions are carried out batchwise in a 2 litre elution column, for both metal and cyanide removal.

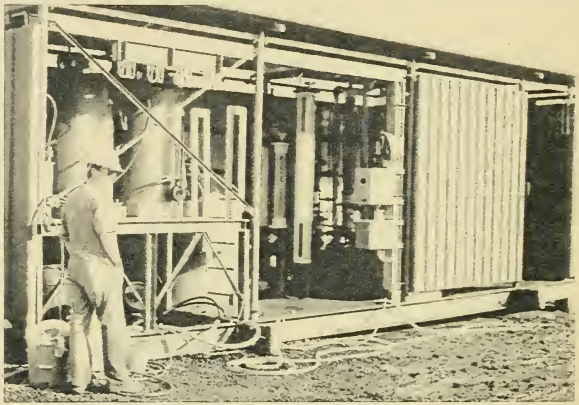
FIGURE 1
LABORATORY RIG FOR CIL AND VITROKELE™ ADSORPTION TESTWORK



AUSTRALIAN PILOTING

The Australian Pilot Plant, shown in Figure 2, consisted of 4 mechanically agitated adsorption tanks in series through which a bleed ($10m^3$/day) of CIL plant tailings flowed.

FIGURE 2
VIEW OF AUSTRALIAN PILOT PLANT



Twice a day the V912 was moved upstream, counter-current to the pulp flow. Adsorbent from the top tank was passed across a recovery screen, washed with water and transferred manually to elution. Two elution steps, one for metal and one for cyanide removal from the Vitrokele™, are required.

Eluate from the cyanide elution was passed to a sealed volatilisation tower, operating at negative pressure relative to atmosphere, where an upflow of air removed the cyanide as HCN gas and carried it to an absorption tower where it was adsorbed by sodium hydroxide to form sodium cyanide.

Spent eluate was not treated further but was discharged to the main plant tailings, along with the sodium cyanide formed by volatilisation and absorption.

GABANINTHA TESTWORK

Initial work concentrated on proving the circuit chemistry and determining the optimum operating parameters for the pilot plant - particularly Vitrokele™ movement rates to obtain low copper and free cyanide values in treated slurry.

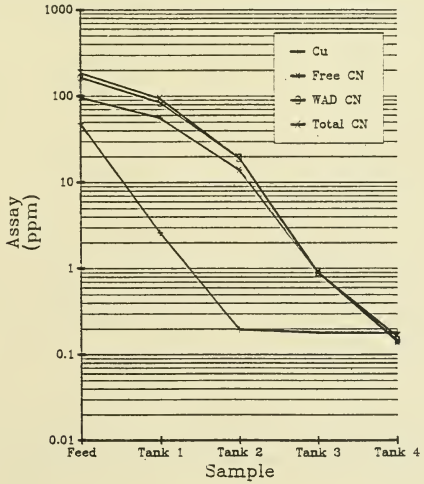
The loading capacity of V912 was found to be approximately 92000ppm for Cu. This result coincided with a loading of 3500ppm Fe. Assuming a complex ratio of 1:4 Cu:CN, this implies a maximum loading of 151000ppm CN on Vitrokele™.

Average adsorption results from the Gabanintha campaigns are shown in Table 2 and graphed in Figure 3. These results represent two campaigns each comprising a 3 day continuous run.

TABLE 2
TYPICAL VITROKELE™ ADSORPTION DATA - GABANINTHA

SPECIES	FEED PULP (ppm in soln)	DISCHARGE PULP (ppm in soln)	RECOVERY (%)
CN_{FREE}	95.8	0.14	99.9
CN_{TOTAL}	185	0.16	99.9
COPPER	47.8	0.18	99.6

FIGURE 3
GRAPHICAL VIEW OF RESULTS FROM TABLE 2



After adsorption of free and complex cyanides from the tailings slurry the loaded V912 is transferred to elution. Depending upon the ratio of free to complex cyanide the relative quantities of V912 transferred to cyanide or metal elution may be varied. The pilot plant had separate elution columns for cyanide and metal elution, the capacities being 30 litres and 15 litres respectively.

Elutions performed during the first campaign indicated that copper elution proceeded rapidly - with 84% Cu removal in 0.5 hours. The circuit comprised an electrowinning circuit for Cu removal, with stripped electrolyte being returned to the elution (similar to a Zadra elution/EW circuit for gold).

Table 3 shows Vitrokele™ metal loading before and after metal elution for the three campaigns at Gabanintha.

TABLE 3

V912 METAL LOADINGS BEFORE AND AFTER ELUTION
(All assays in ppm unless otherwise noted)

SAMPLE		LOADED Cu	LOADED Fe	ELUTED Cu	ELUTED Fe	% RECOVERY Cu	% RECOVERY Fe
M1	C1	92000	3530	2350	170	97.4	95.2
M2	C1	43000	2770	530	50	98.8	98.2
M3	C1	58000	3080	2820	184	95.1	94.0
M4	C1	47000	2260	18000	240	61.7	89.4
MEAN	C1	60000	2910	5925	161	88.3	94.2
M5	C2	68900	3450	13000	130	81.1	96.3
M6	C2	39700	3400	12800	197	67.8	94.2
M7	C2	57400	3550	9800	105	82.9	97.0
MEAN	C2	55333	3467	11867	144	77.3	95.8
M8	C3	37000	2500	5200	130	85.9	94.8
M9	C3	N/A	N/A	N/A	N/A		
M10	C3	54500	4150	670	300	98.8	92.8
M10 & CN21				260	100	99.5	97.6
M11	C3	43800	3100	1310	120	97.0	96.1
M11 & CN24				680	70	98.4	97.7
M12	C3	36150	3150	440	140	98.8	95.6
M12 & CN27				240	75	99.3	97.6
M13 & CN32		49800	5000	270	210	99.5	95.8
MEAN	C3	46063	3850	553	145	98.8	96.2

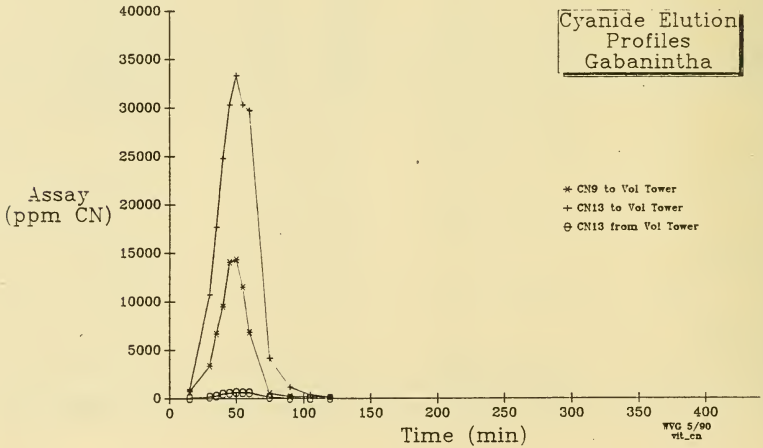
It can be seen from Table 3 that campaign results are good with an average elution efficiency of 98.8% for Cu and 96.2% for Fe.

The procedure for cyanide elution was to elute the resin with 5% sulphuric acid. The acid liquor passes from the elution column directly to the volatilization tower where the hydrogen cyanide is stripped into the circulating gas flow. The circulating gas then passes through the cyanide recovery tower where hydrogen cyanide is stripped from the gas into sodium hydroxide solution, thus resulting in a solution of sodium cyanide. The cyanide concentration of the caustic soda solution was allowed to build up to approximately 20% NaCN before bleeding some of the liquor and replacing it with fresh NaOH.

There was no direct assay of cyanide loaded onto V912. The cyanide elution was monitored by assaying the elution liquors and observing the cyanide eluted. This was compared to the cyanide recovery during adsorption (calculated by mass balance) to determine the effective cyanide loading of the Vitrokele™.

As can be seen from the elution profiles of two cyanide elutions (Figure 4), the elution of free cyanide is rapid and substantially complete in 2 hours.

FIGURE 4
CYANIDE ELUTION PROFILES - GABANINTHA



Also shown in Figure 4 is the profile of cyanide concentrations after volatilization - a single pass through this column recovered 97%of the cyanide in solution.

COSMO-HOWLEY TESTWORK

Site trials were conducted during February 1990 at Cosmo-Howley Mine - a 2 Mtpa CIL plant near the Adelaide River in the Northern Territory - to determine the effectiveness of Vitrokele™ technology for economic recovery of cyanide.

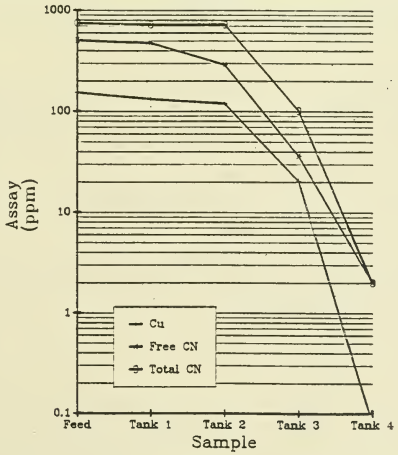
In addition, minor supplementary programs were undertaken to examine gold recovery by Vitrokele™ and a laboratory investigation of the influence of pulp density on adsorption performance.

Table 4 and Figure 5 show typical adsorption results obtained during the campaign.

TABLE 4
TYPICAL ADSORPTION DATA - COSMO-HOWLEY

SPECIES	FEED PULP (ppm in soln)	DISCHARGE PULP (ppm in soln)	RECOVERY (%)
CN_{FREE}	506	2.0	99.6
CN_{TOTAL}	749	2.0	99.7
COPPER	153	0.08	99.9

FIGURE 5
GRAPHICAL VIEW OF RESULTS FROM TABLE 4



During this campaign, testwork was performed to establish whether the circuit could be run for cyanide recovery only, by allowing the Vitrokele™ to become saturated with copper and only performing cyanide elutions.

Initially the recovery of cyanide was good, but it deteriorated with time, due to the removal of copper from the Vitrokele™ by a competing species, probably thiocyanate. Thiocyanate levels in the Cosmo-Howley tailings slurry were in the order of 300 ppm compared with less than 20ppm at Gabanintha.

Part of the on-site testwork involved operating the pilot plant on feed from the first pre-leach tank. This slurry contained substantial quantities of gold. The objective of this testwork was to show that gold would load onto Vitrokele™ that was saturated with copper. The implication being that if a full-size plant was operated to recover free cyanide only (that is, not to recover copper cyanide) it would still scavenge gold which could be recovered by eluting a small bleed stream of the total Vitrokele™ flow.

These tests were performed using Vitrokele™ close to saturation with copper and iron, the plant being operated for a single continuing period of 15.25 hours, with no Vitrokele™ advancement. Adsorption results showed little Cu or Fe recovery due to saturation of the Vitrokele™ with these species, but gold recovery was good at 92%.

Gold loaded Vitrokele™ was eluted using conditions employed during trials at Gabanintha which had proved to be effective in reducing copper and iron levels on the Vitrokele™. Samples of the eluate were taken for assay during the course of the elution to follow its profile; these are shown in Figure 6. Overall elution performance is shown in Table 5.

FIGURE 6
METAL ELUTION PROFILE - COSMO-HOWLEY

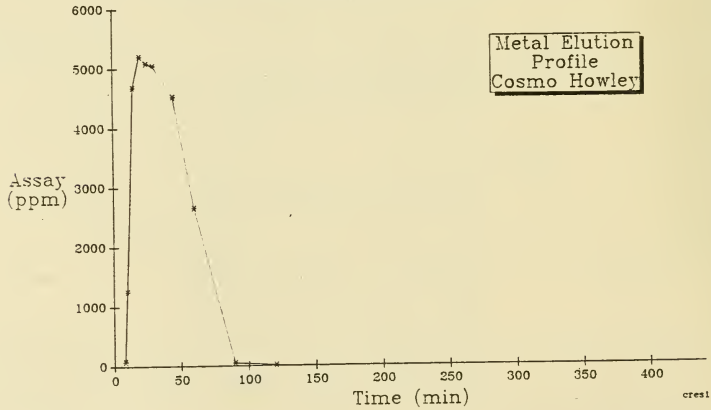


TABLE 5
ELUTION PERFORMANCE - COSMO-HOWLEY

	LOADED V912 (ppm)	ELUTED V912 (ppm)
CN_{FREE}	93,500	<1,000
CN_{TOTAL}	117,000	<1,000
COPPER	57,000	2,100
GOLD	472	530

Elution of copper is quite rapid, but that of gold very slow. The apparent increase in gold loading after elution is due to the removal of only a small proportion of the gold during elution, while almost all the cyanide and copper are removed. This results in a significant lowering of the density of the Vitrokele™, and hence the apparent increase of gold loading.

In practice therefore, when treating tailings material where Vitrokele™ scavenges residual gold, the gold loading would reach a steady condition where the gold entering the circuit during the adsorption equals the fraction removed during a normal metal elution.

If Vitrokele™ were to be used for gold recovery, in place of CIP, a separate gold elution circuit would be required.

Other conclusions from the Cosmo-Howley testwork were that:

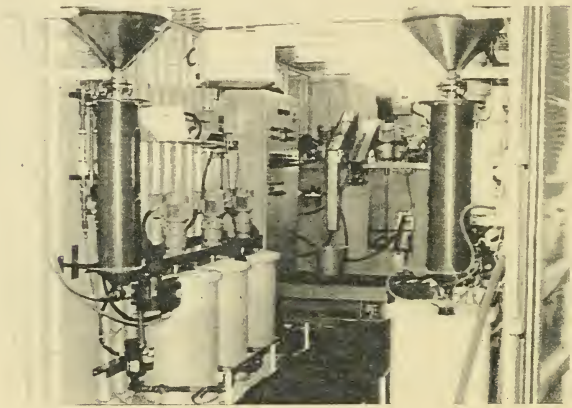
- varying slurry densities of 0 - 56% solids (Cosmo-Howley pulp exhibited marked increases in viscosity over the range 45 - 56% solids - typical Bingham plastic behaviour) had no affect on the adsorption rates of the copper and cyanide.

- the Vitrokele™ used at Cosmo-Howley was the same inventory used at Gabanintha. No physical or chemical degradation of the Vitrokele™ was detected.

- due to the regular size and shape of the Vitrokele™ beads, handling and screening characteristics of Vitrokele™ in pulp were excellent.

PILOT PLANT OPERATION IN NORTH AMERICA

FIGURE 7
GENERAL VIEW OF NORTH AMERICAN PILOT PLANT

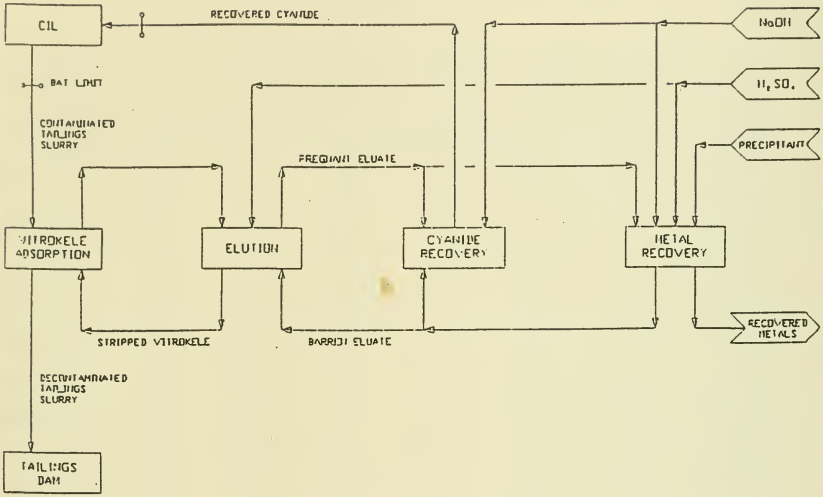


The pilot plant constructed in North America (Figure 7) differs from the Australian plant in that it has:

- 5 adsorption stages;
- no AVR circuit - cyanide eluate being recycled to leach as a 2% solution;
- copper precipitation using sodium sulphide;
- zinc recovery (metal eluant recycle) using conventional ion exchange.

Figure 8 shows a simplified flowsheet of the pilot plant, which was designed to duplicate a commercial installation. The plant throughput was $10m^3$/day, and it was designed for 24 hour continuous operation.

FIGURE 8
VITROKELE DEMONSTRATION PLANT BLOCK FLOWSHEET



The first campaign was successful in achieving desired loading capacities of V912 for copper and cyanide but the circuit failed to produce the specified discharge limits of Cu and cyanide due to problems with the Vitrokele™ transfer pumps.

Design Vitrokele™ transfer rates required small pumps and pipelines and these suffered from blockages and sanding out, a pilot plant problem that would not occur in larger installations. This transfer pump problem was eventually solved by employing larger pumps.

A second continuous 10 day campaign was run to confirm that a Vitrokele™ adsorption circuit was capable of continuously polishing to low discharge levels of cyanide and heavy metals.

Tables 6, 7 and 8 show results obtained by the adsorption circuit during this second 10 day campaign.

TABLE 6
FREE CYANIDE LEVELS (ppm) IN ADSORPTION
2nd CAMPAIGN

DATE	TIME	FEED	TANK 1	TANK 2	TANK 3	TANK 4	TANK 5
05/05	22:00	328	229	117	13.4	0.22	0.14
05/06	16:00		245	72.3	4.27	0.53	0.32
05/07	05:00	326	225	69.4	5.12	0.64	0.43
05/07	16:00		162	32.9	5.14	0.44	0.22
05/08	13:15	257	124	28.7	2.00	0.30	0.30
05/09	05:00	270	133	20.4	1.68	0.35	0.25
05/09	16:00	263	137	19.7	1.00	0.30	0.30
05/10	01:00	323	125	15.7	0.92	0.31	0.19
05/10	15:30	300	133	9.0	0.67	0.39	0.42
05/11	01:00	295	109	5.9	0.50	0.30	0.25
05/11	15:30	283	75.8	3.8	2.16	0.38	0.43
05/12	01:00	286	71.8	3.0	0.33	0.12	0.23
05/12	15:30	304	63.8	2.5	0.15	0.26	0.26
05/13	01:00	290	85.3	2.6	0.23	0.37	0.25
05/13	15:30	290	73.5	2.5	0.25	0.18	0.20
AVERAGE:		293	132.8	27.0	2.52	0.34	0.28

TABLE 7
TOTAL CYANIDE LEVELS (ppm) IN ADSORPTION
2nd CAMPAIGN

DATE	TIME	FEED	TANK 1	TANK 2	TANK 3	TANK 4	TANK 5
05/05	22:00	343	323	171	14.8	0.54	0.30
05/06	16:00		291	96.4	4.28	0.49	0.34
05/07	05:00	348	297	103	9.00	0.43	0.31
05/07	16:00		218	47.1	9.85	0.28	0.20
05/08	13:15	343	188	37.2	3.66	0.31	0.43
05/09	05:00	334	206	30.8	5.37	0.26	0.19
05/09	16:00	274	176	24.4	13.7	0.28	0.17
05/10	01:00	351	171	22.3	4.86	0.22	0.17
05/10	15:30	389	175	15.2	6.85	0.55	0.02
05/11	01:00	377	163	13.6	2.86		0.06
05/11	15:30	283	111	5.57	0.29	0.28	0.02
05/12	01:00	377	111	6.28	3.86	0.28	0.19
05/12	15:30	394	116	4.86	1.29	0.35	
05/13	01:00	386	122	4.00	2.28	0.22	0.20
05/13	15:30	168	78.3	0.14	0.29	0.37	0.26
AVERAGE:		336	183	38.8	5.55	0.35	0.20

TABLE 8

COPPER LEVELS (ppm) IN ADSORPTION
2nd CAMPAIGN

DATE	TIME	FEED	TANK 1	TANK 2	TANK 3	TANK 4	TANK 5
05/05	22:00	131	263	161	17.2	0.66	0.28
05/06	16:00		229	99.0	5.47	0.54	0.31
05/07	05:00	155	237	92.5	7.11	0.59	0.30
05/07	16:00		162	48.0	6.63	0.56	0.23
05/08	13:15	131	148	39.5	2.69	0.45	0.29
05/09	05:00	224	283	52.5	2.36	0.46	0.22
05/09	16:00	113	124	19.2	1.53	0.46	0.22
05/10	01:00	114	126	17.8	1.29	0.34	0.17
05/10	15:30	18.7	19.1	1.40	0.10	0.04	0.03
05/11	01:00	18.6	17.0	1.18	0.12	0.04	0.03
05/11	15:30	114	68.8	4.49	0.38	0.21	0.20
05/12	01:00	119	67.8	3.47	0.56	0.20	0.14
05/12	15:30	134	129	2.69	0.35	0.23	0.21
05/13	01:00	21.8	12.4	0.44	0.07	0.04	0.03
05/13	15:30	19.5	11.4	0.42	0.05	0.03	0.02
AVERAGE:		101	126.5	36.2	3.1	0.32	0.18

Throughout this campaign, copper discharge levels remained below 0.3ppm and cyanide levels below 0.5ppm, reduced from feed levels of approximately 150 and 350 ppm respectively.

The behaviour of the adsorption circuit in response to a stoppage in V912 movement (transfer upstream and return from elution) was followed for 16 hours. During this time cyanide and copper values in the discharge stream both remained below 0.5ppm, but were clearly rising after 12 hours. The implication from this test is that the normal inventory of V912 in an adsorption circuit has sufficient loading capacity to cater for feed surges or circuit malfunctions for a significant period without stopping feed to the plant.

Biotoxicity tests and solution analyses were performed by an independent consultant on pulp filtrates sampled on 13/05/91 and are shown on Table 9 and 10.

The rainbow trout bio-assay results indicate that the residual toxicity in the pilot plant discharge was low. The chemical analyses (Table 10) suggest that the observed toxicity was mainly attributable to ammonia. Ammonia is largely produced by the catalytic breakdown of cyanide by carbon, and is not removed by V912.

TABLE 9

PILOT PLANT DISCHARGE TOXICITY TESTS[1] (RAINBOW TROUT)
2nd CAMPAIGN

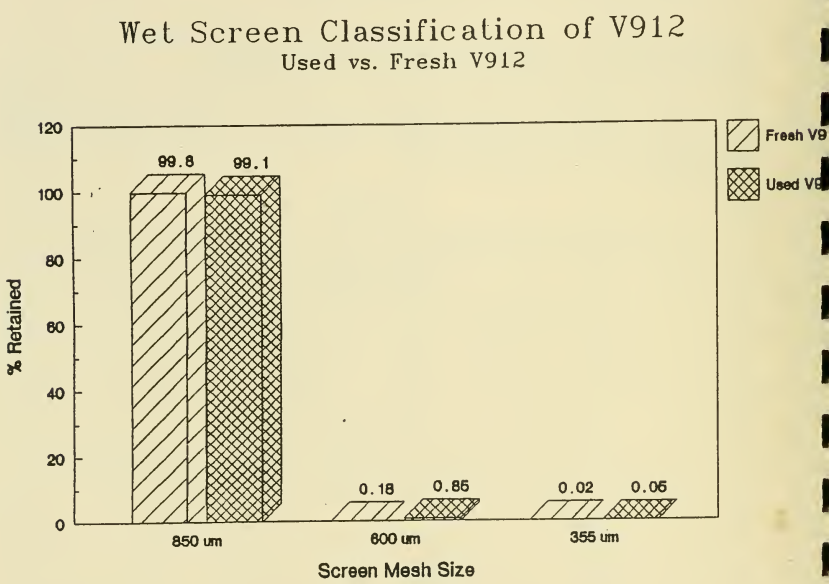
pH	LC_{50} (%v/v)
7	66
9	18

TABLE 10
CHEMICAL ANALYSES OF TOXICITY TESTS SAMPLES (ppm)

NH_4	28	Na_{sol}	530
Zn_{sol}	0.02	K_{sol}	23
Zn_T	<0.01	Cl	N/A
Fe_{sol}	0.02	NO_3	1.79
Fe_T	0.84	SO_4	N/A
Mg_{sol}	1.75	ALKALINITY	0.049
Ca_{sol}	760	CNO	N/A
Cu_{sol}	0.070	CN_{WAD}	0.009
Cu_T	0.175	SCN	N/A

The two test campaigns together with circuit optimization testing, comprised a total in-circuit duty cycle of about 50 days. Previous experience has indicated that the losses which occur during a period of even several weeks cannot be determined by either mass or volume audits because the errors inherent in the determination are of the same magnitude as the losses of Vitrokele™ At the end of the second campaign, a composite sample of used Vitrokele™ was compared with unused Vitrokele™ by wet screening (see Figure 9). During the course of the total on-site operating period, no fresh Vitrokele™ was added to the inventory in plant use.

FIGURE 9



The results of the wet screening comparison do indicate a decrease in the size of the used Vitrokele™ relative to unused V912. However, the extent of this reduction is small (see Figure 9). It Should be noted in particular that the adsorption circuit inter-stage screens are 600 microns and that there is no significant near-size loading increase on these screens following the approximately 1200 hours of plant operation. Most of the Vitrokele™ in the used inventory is above 850 microns. Neither is significant loading of near-size in the safety screen size range (355 microns) indicated.

SUMMARY OF PILOT PLANT OPERATIONS

It is clear from the above that a Vitrokele™ circuit for the recovery of cyanide and removal of copper from gold effluents is technically achievable.

The circuit chemistry has been proven, and the unit processes required for efficient utilization of this chemistry are all well understood within the minerals processing industry.

Pilot plant operations have shown that Vitrokele™ handling in pulp is practically possible as demonstrated by:

- no difficulties with in-tank screening of Vitrokele™ from pulp (even in highly viscous slurries);
- proper dispersion of V912 beads in a mechanically agitated tank;
- low abrasion losses of V912.

Furthermore, the elution of loaded species from Vitrokele™ has been shown to be rapid and efficient using common chemicals at ambient temperature.

More work is required on the metal recovery and zinc recycle sections of the plant to improve efficiencies for full scale operations - this is planned for future campaigns.

Our experience to date has also indicated that results obtained during bench scale work and laboratory scale flow through tests are repeatable in the pilot plant.

LARGER SCALE DEVELOPMENTS

A fairly large-scale fully integrated plant is required to effectively demonstrate the Vitrokele™ process and to supply valid cost and design data for the process.

The pilot plant work at Cosmo-Howley mine in Australia provided operating cost data and, on the basis of this work, a full scale plant was designed and costed.

The plant design parameters were:

solids capacity	Mtpa	2.0
pulp density	% solids	49.8
slurry flow rate	m^3/hour	341
free cyanide CN^-	ppm	357
total cyanide CN^-	ppm	536
Copper as Cu	ppm	140
plant location	outside (no building required)	

A similar exercise has been undertaken for a plant in North America to handle 2 million gallons per day of solution requiring polishing before discharge and a lump sum proposal is currently being compiled for cyanide recycle and copper recovery at a copper/gold mine in Australia.

Design work undertaken for the pilot plants and for the above cost estimates has indicated no unusual design problems associated with the process either in terms of layout or materials of construction.

OTHER APPLICATIONS IN THE MINING INDUSTRY

Programs to date have been oriented towards the economic recycle of cyanide from gold plant effluents, as well as the recovery of cyanide and removal of copper from tailing streams for environmental reasons. Several other applications within the gold mining industry are suggested.

- Vitrokele™ in pulp as a replacement for CIP or Merril-Crowe circuits. Some testwork has already been conducted in this area and has shown gold recovery by VIP to be feasible. A VIP gold recovery circuit could comprise a single circuit for gold recovery and production of environmentally acceptable effluents.

- VIL is also a viable process because Vitrokele™ can be conditioned to adsorb only metal cyanide complexes and not free cyanide.

- Some gold recovery plants may presently be operating leach circuits at cyanide levels controlled for environmental considerations and not optimum for gold recovery. Operating such circuits at higher cyanide concentrations and recycling cyanide may increase gold production.

- Some potential exists for Vitrokele™ applications in copper gold operations, both in optimization of the leach circuit (cyanide levels) and in the recycle of clean water (cyanide free, for sulphide flotation).

- Vitrokele™, like activated carbon, can be used in slurry or solution circuits. It thus has applications in clean up of existing evaporation or polishing ponds, producing clean water for other uses or discharge to local water courses.

- Because of the potential for reduced working costs due to cyanide recycle with Vitrokele™, some ores that are presently uneconomic to treat (due to high cyanide requirements) may become viable.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of Jasmetech, particularly Martin Macdonald and Derek Hall for their dedication during the pilot plant campaigns.

The pilot plant work could not have been possible without the support of Dominion Mining in Australia, BP Canada and Canamax. The assistance provided on-site by their plant personnel is gratefully acknowledged. Much of the Australian laboratory test program was completed under the direction and supervision of Michael J. Noakes and Associates of Sydney, Australia.

CYANIDE RECOVERY USING VITROKELE^{R} TECHNOLOGY:

PROJECTED ECONOMIC ANALYSES

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INTRODUCTION

VITROKELE[R] cyanide recovery technology has been successfully piloted at the Gabanintha and Cosmo-Howley mines by Nedpac Engineering Pty. Ltd. The pilot campaigns were designed to confirm technical and economic feasibility of the recovery process including the production of base metal concentrates and return of re-useable cyanide to the leach circuit. The capital and operating costs of full-scale plants is now able to be estimated to within ±20% on the basis of hydrometallurgical data. Firm quotes are subject to on-site test-work, and any special requirements or site peculiarities.

PILOTING

The existing pilot plant comprises a four stage contacting of CIP pulp discharge, with countercurrent transfer of Vitrokele[R] 912 (V912). The V912 is stripped and then acid-treated before return to the adsorption circuit. The stripped base metals are removed by precipitation and any stripped gold is returned to the head of the leach circuit with recovered cyanide. Copper is recovered as a sulfide concentrate suitable for smelting.

Typical performance of the 4-stage Gabanintha Pilot Plant is shown in Figure 1.

Figure 1

It should be noted that this plant was built and operated for the economic recovery of cyanide and metal credits. Where the process is operated to produce discharge to meet environmental discharge specifications, a further 2 contact stages may be required. However, the additional tankage does not add greatly to the capital cost of the plant. Capital and operating costs are closely tied to the quantity of metal in the feed. Net benefits are most closely linked to

recoverable cyanide levels. However, the replacement of chemical cyanide destruction, which generally costs upwards of US$0.25 per tonne of mill throughput, can dramatically influence the economics of cyanide recovery.

DATA BASE FOR COST ESTIMATES

The information required from mill operators for economic analyses is shown in Table 1. Details of water return to the mill are also required. Where cyanide destruction is being employed, the costs of this are also required for a complete cost/benefit analysis.

Table 1

The avoidance of longer term costs and contingent liabilities associated with tailings management are frequently substantial. However, benefits are site specific and are generally only assessable by the mine operator.

None of the economic analyses used in the present paper include credits resulting from the replacement of environmental measures such as cyanide destruction. Thus all analyses are based upon the recovery of useable cyanide. In some cases metal credits such as gold and copper are included depending on whether or not such credits are clearly achievable.

PREDICTING ECONOMICS OF CYANIDE RECOVERY

While high levels of recoverable cyanide are indicative of favourable economics, other parameters are also important. A plot of the economic pay-back period against recoverable cyanide concentrations (Figure 2) indicates that this is not a reliable indication of the return on investment.

Figure 2

Neither is the correlation improved by including mill throughput. What is noteworthy about the analysis shown in Figure 2, is that the 0.9 year spread of pay-back periods is relatively narrow. The eight projects analyzed were in the range 750,000 to 6,000,000 tpa. Subsequent analyses confirm the relatively narrow spread of pay-back periods. However it should be mentioned that, in general, a low (under 2 years) pay-back period for cases involving recoverable cyanide below 100ppm will only be found for cases where it is necessary for environmental measures, such as cyanide removal, to be taken.

The lowest recoverable cyanide case examined, so far, is 30ppm. This was economic on the basis of an assumed cyanide destruction cost of US$0.25pt mill throughput. The payback period was 1.1 years.

CASE STUDIES

A summary of economic analyses involving projects from Canada, USA, and Australasia are presented in Tables 2.1, 2.2 and 2.3.

Table 2.1
Table 2.2
Table 2.3

The operating parameters shown in the Tables 2.1, 2.2 and 2.3 are those derived from the data supplied by the mill operators, and the tonnages of V912 which are required to be stripped each day. Because the batch stripping time is under one hour, the tonnage in the elution circuit at any one time is not great.

Credits are similarly derived on a project-specific basis and reflect both local prices and opportunities to realise recovered metal values. In 2 cases, copper credits are

not included in the calculation of pay-back because of high transport costs for smelting. In a further 2 cases gold credits were not included on the basis that soluble gold values in the mill discharge were indicated, by the operator, to be under 0.005ppm. The range of operating credits available to these eight projects is summarized in Table 3.

Table 3

Operating costs are based upon local conditions and prices. The base employed is generally lime, but in some instances caustic has been the choice.

The allowance for V912 make-up is based upon an annual inventory replacement rate of 30%. However, long-term tests indicate that the replacement rate should be significantly less than this.

Pay-back periods include both capital and operating costs, and so are true break-even points for cash-flowing the investment.

Where further allowances can be made for the replacement of existing discharge abatement the pay-back periods can be reduced even further. Such allowances are generally possible for North America but are less likely for Australasian projects.

TABLE 1

VITROKELE^{R}-APPLICATION DATA SHEET

TREATMENT STREAM:

RATE tonnes/h:
SOLIDS SG:

SOLUTION SG:
PULP DENSITY:

SOLUTION ASSAY (PPM)

	Feed	Required Effluent		Feed	Required Effluent
pH			Au		
eH (mV)			Ag		
Temp			As		
CN_{WAD}			Fe		
CN_T			SCN		
Cu			Hg		
Zn					

COSTS

CURRENCY:

REAGENTS (FOT MINESITE)		SERVICES (COST/AVAILABILITY)	
NaOH:		Power:	
H_2SO_4:		Water:	
NaCN:		Air:	
$Ca(OH)_2$:			

SITE CHARACTERISTICS

Rainfall:
Earthquake zone:

Temp Range:
Altitude:

TABLE 2.1: ECONOMIC ANALYSIS SUMMARIES FOR VITROKELE[R] CYANIDE RECOVERY: CANADIAN PROJECTS.

PROJECT#	CAN 1	CAN 2	CAN 3
OPERATING PARAMETERS			
Recoverable CN (ppm)	500	400	936
Copper/Zinc (ppm)	300	170	141
Annual Tonnage (solids) Mtpa	0.8	1.0	2.08
Slurry Density (% solids)	45	45	49.8
Qty Vitrokele stripped/day	183.6	90.0	317.0
CREDITS ($000 CAN/a)			
NaCN	1,846	2,413	4,643
Copper	568	259	589
Gold	255	333	NI
Silver	NI	NI	NI
TOTAL	2,669	3,005	5,232
OPERATING COSTS ($000 CAN/a)			
Power	72	52	218
H_2SO_4	341	610	1,232
Base	134	159	454
Na_2S	127	94	165
Labour & Maintenance	165	165	200
V912 Makeup	60	90	NA
TOTAL	899	1,170	2,269
Total Credits/a	2,669	3,005	5,232
Total Operating Costs/a	899	1,170	2,269
NET REVENUE/a	1,770	1,835	2,963
CAPITAL COST ($000 C)	2,943	2,936	3,645
PAY BACK (years)	1.66	1.6	1.23

NI = not included in calculations
NA = not available

TABLE 2.2: ECONOMIC ANALYSIS SUMMARY FOR VITROKELE[R] CYANIDE RECOVERY: USA PROJECTS

PROJECT#	USA 1	USA 2	USA 3A
OPERATING PARAMETERS			
Recoverable CN (ppm)	600	398	250
Copper/Zinc (ppm)	250	400	0
Annual Tonnage (solids) Mtpa	3.1	2.5	1.2
Slurry Density (% solids)	45	45	45
Qty Vitrokele stripped/day	349.2	259.2	18
CREDITS ($000 US/a)			
NaCN	7,468	3,836	1,423
Copper	NI	1,450	0
Gold	3,496	480	162(NI)
Silver	152	NI	NI
TOTAL	11,116	5,766	1,423
OPERATING COSTS ($000 US/a)			
Power	145	113	65
H_2SO_4	519	609	90
Base	370	305	49
Na_2S	393	534	7
Labour & Maintenance	330	330	135
V912 Makeup	210	150	60
TOTAL	1,967	2,041	406
Total Credits/a	11,116	5,766	1,423
Total Operating Costs/a	1,967	2,041	406
NET REVENUE/a	9,149	3,725	1,017
CAPITAL COST ($000 US)	6,400	4,600	1,970
PAY BACK (years)	0.75	1.23	1.9

NI = not included in the calculations

TABLE 2.3: ECONOMIC ANALYSIS SUMMARY FOR VITROKELE[R] CYANIDE RECOVERY: AUSTRALIAN PROJECTS

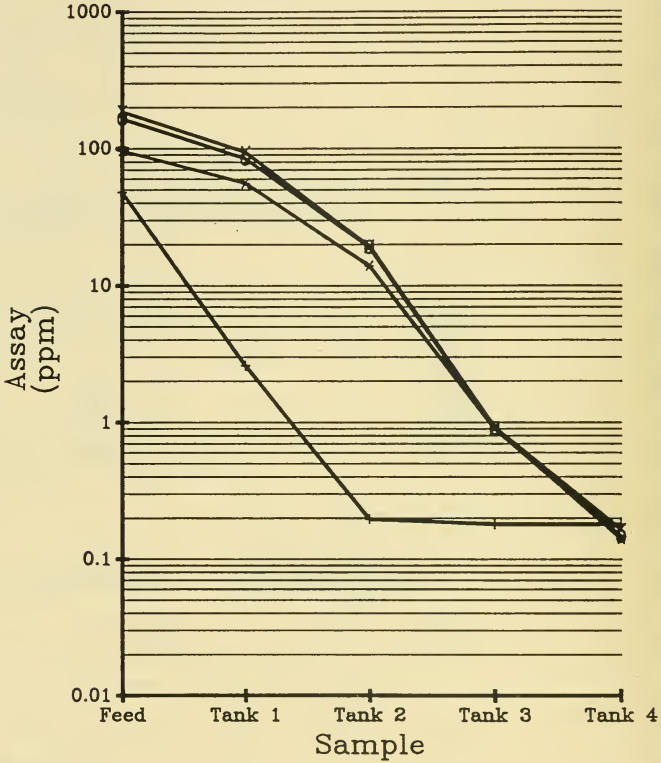
PROJECT#	AUS 1	AUS 2	AUS 3
OPERATING PARAMETERS			
Recoverable CN (ppm)	233	79	636
Copper/Zinc (ppm)	10	15	440
Annual Tonnage (solids) Mtpa	0.72	6.4	1.0
Slurry Density (% solids)	34	41	40
Qty Vitrokele stripped/day	39.4	93.72	168.08
CREDITS ($000AUS/a)			
NaCN	1,845	3,428	5,308
Copper	29	276	1,323
Gold	NI	NI	437
Silver	NI	NI	236
TOTAL	1,874	3,704	7,304
OPERATING COSTS ($AUS/a)			
Power	50	330	74
H_2SO_4	178	359	869
Base	99	660	541
Na_2S	6	60	284
Labour & Maintenance			
V912 Makeup	NA	NA	90
TOTAL	333	1,409	2,047
Total Credits/a	1,874	3,704	7,304
Total Operating Costs/a	333	1,409	2,047
NET REVENUE/a	1,541	2,295	5,257
CAPITAL COST ($000 A)	2,200	3,600	4,180
PAY BACK (years)	1.43	1.57	0.8

NI = not included in the calculations
NA = not available

TABLE 3: CREDITS ASSOCIATED WITH CYANIDE RECOVERY: 8 PROJECTS

CREDIT	RANGE ($,000)
Cyanide	1,845 - 12,678
Gold	45 - 3,496
Silver	0 - 236
Copper	0 - 1,450
Cost Avoidance:	
Cyanide destruction	0 - 3,100
Tailings management	unassessed
Pay-Back (years)	0.75 - 1.66

Typical Solution Assays for Vitrokele Adsorption Circuit at Gabanintha



WVG 5/90
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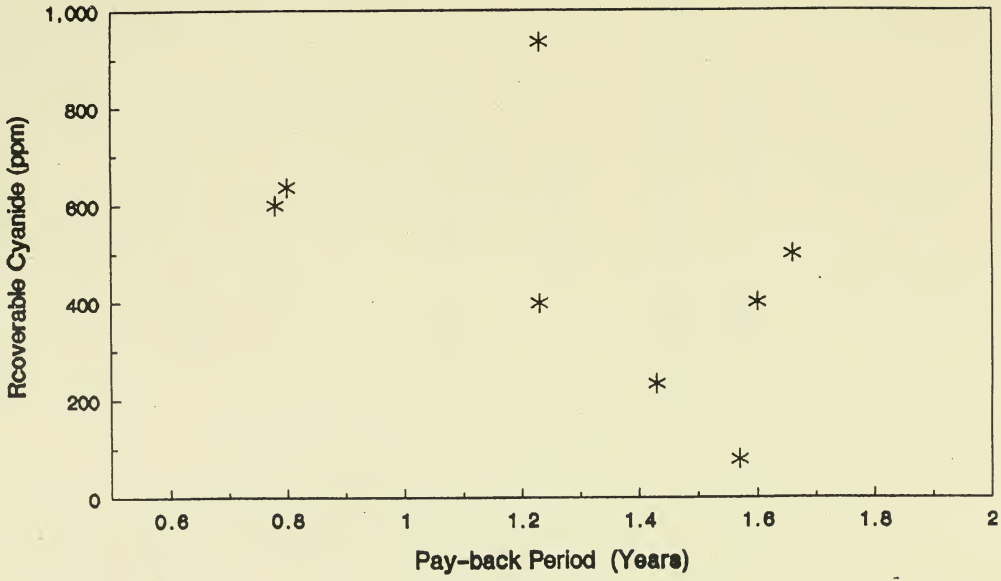
Cyanide recovery as an Investment



Metals Control Using

Sodium Dimethyldithiocarbamate

Appendix 8

of the

Development Document

VINMET 1140

Heavy Metals Removal Chemistry

Description

VINMET 1140 is an aqueous solution of sodium dimethyldithiocarbamate, $(CH_3)_2NCS_2Na$, effective in precipitating low concentrations of precious and heavy metal ions from industrial aqueous effluent. VINMET 1140 is recommended as a polishing chemical for effluent containing 5 to 500 ppm of total metal ions. VINMET 1140 should also be considered as an alternative or adjunct to other more conventional techniques for the precipitation of much higher levels of disolved metal ions. VINMET 1140 is extremely effective in precipitating various free, complexed, and chelated metals, such as copper, nickel, cadmium, chromium^{+3}, gold, silver, iron, magnesium, mercury, nickel, and zinc. The insoluble metal complexes may appear as colloidal precipitate or as sizeable floc, depending on the particular waste stream. Many metal-dithio complexes meet the EPA landfill leach stability testand therefore can be directly discharged in appropriate state landfills. The precipitation reaction is:

$$2\,[\,(CH_3)_2NCS_2^-Na^+\,] + M^{+2} \longrightarrow 2\,[\,(CH_3)_2NCS_2^-\,]\,M^{+2} + 2Na^+$$

Typical Properties

Appearance:	Yellow - green liquid
Activity:	40%
Density:	9.6 lb/gal
pH:	12.5 ± 1.0
Solubility in Water:	Complete

Application

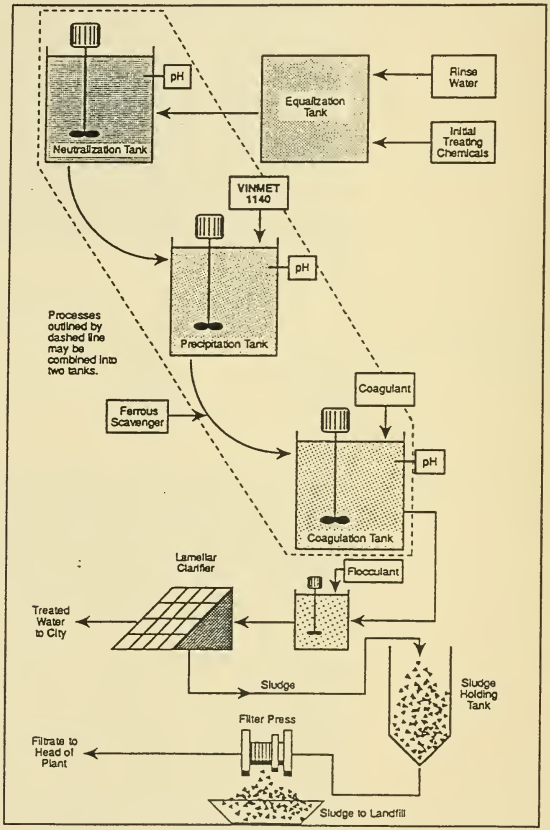
In general, the approximate treatment rate of VINMET 1140 for a particular metal ion can be calculated by multiplying the metal ion valence by 358 and then dividing by the atomic weight of the metal. It is recommended to treat a system with 10 to 20% excess of the stoichiometric equivalent. Where the concentration of metal ions is less than 5 ppm, treatment with VINMET 1140 may not be as efficient as with waste streams with higher concentrations. If possible, low concentration waste streams should be cycled-up in order to gain improved efficacy and economy of treatment.

VINMET 1140 functions over a broad pH range, however when possible pH should be adjusted to approximately 9.0. After pH adjustment of the waste stream VINMET 1140 can be added either continuously or on a batch basis as required. Agitation of the treatment vessel is beneficial in increasing product performance. After the waste stream has been agitated for an optimized contact time, determined depending on the particular metal ion and other waste contaminants, the addition of a medium charge density cationic or anionic polyacrylamide, or other cationic polyelectrolyte will enhance the rate of flocculation and dewatering characteristics of the precipitated metal sludge. The following diagram shows the typical points of

Application
(continued)

addition for the various treatment components in a typical VINMET system.

Typical VINMET 1140 Metal Plating Waster Water Schematic



Typical Treatment Rates vs. Various Metals

Parts VINMET 1140 vs. Part Metal Ion

Metal	Dosage	Metal	Dosage
Ag^{+}	4	Fe^{+2}	14
Au^{+}	2	Fe^{+3}	21
Au^{+3}	6	Hg^{+}	2
Cd^{+2}	7	Hg^{+2}	4
Cu^{+}	6	Mg^{+2}	33
Cu^{+2}	12	Ni^{+2}	13
Cr^{+3}	23	Zn^{+2}	12

Program Comparisons

VINMET 1140 offers a number of advantages over other technologies for removing metal ions.

VINMET vs. ferrous sulfate:

- Superior removal of metal ions
- Elliminates additional sulfate requirements
- Reduces acid and caustic demand
- Significantly reduces sludge volume

VINMET vs. sodium hydrosulfite:

- Superior removal of metal ions
- Reduces acid and caustic demand
- Significantly reduces sludge volume
- Elliminates toxic dust

VINMET vs. sodium borohydride:

- Superior metals precipitate stability
- Reduced treatment cost
- Superior flocculation tendancies
- Reduced sludge disposal costs due to superior stability
- Reduced pH sensitivity

Polymer Coadditives

The precipitation and dewatering of VINMET complexed metal sludge can generally be enhanced through the addition of polymers and coagulants. In most applications an anionic polyacrylamide, approximately 30% charge density, should be evaluated for improved sludge formation, enhanced dewatering characteristics of the sludge, and improved clarity of the effluent stream. A cationic polyacrylamide, approximately 65% charge density, or polyamine should also be evaluated for sludge enhancement and water clarification, especially in those cases where an anionic polymer does not yield clear effluent.

Vinings Industries Inc.
1-800-347-1542

Sodium Dimethyldithiocarbamate (SDDC)
Half Life in Water

In dilute aqueous solutions (ie. in test conditions similar to system application), sodium dimethyldithiocarbamate decomposes. The effect of pH and light (photolysis) are shown in the following half-life table.

pH	Hydrolysis	Photolysis
5	0.3 hrs	0.43 hrs
7	25.9 hrs	17.6 hrs
9	433.3 hrs	21.2 hrs

Source: Hazleton Laboretories, Madison, WI. "Photo-degradation and Hydrolysis of 14C-SDDC in Buffered Aqueous Solutions". May, 1987.

40% SDDC Toxicity

Type of Data	Test	Species	Result	Date
Acute Inhalation	LC_{50}	Rat	>2.19 mg/l	3/86
Acute Oral Toxicity	NOEL	Bobwhite	292 mg/kg	3/86
Acute Oral Toxicity	LD_{50}	Bobwhite	91 mg/kg	3/86
Acute Toxicity	48 hr. LC_{50}	Daphnia Magna	1.5 mg/l	12/85
Acute Toxicity	96 hr. LC_{50}	Bluegill Sunfish	3.3 mg/l	1/86
Acute Toxicity	96 hr. LC_{50}	Rainbow Trout	0.85 mg/l	1/86
Acute Toxicity	96 hr. LC_{50}	Rainbow Trout	0.85 mg/l	1/86
Dermal Sensitization		Guinea Pig	Not a sensitizer	2/86
Dietary LC_{50}	LC_{50}	Mallard	4688 ppm	3/86
Dietary LC_{50}	NOEL	Mallard	562 ppm	3/86
Dietary LC_{50}	LC_{50}	Bobwhite	>5620 ppm	3/86
Acute Toxicity (Static)	96 hr. LC_{50}	Mysid Shrimp	2.7 ug/l	11/86
Acute Toxicity (Static)	NOEL	Mysid Shrimp	0.64 ug/l	11/86
Acute Toxicity (Static)	48 hr. LC_{50}	Hard Shell Clam	2.0 ug/l	11/86
Nitrosamine Content	HPLC-TEA	Volatile	680 ppb	12/85
Nitrosamine Content	Gas Chromotography	Volatile	<0.1 ppm	2/78
Nitrosamine Content	Mass Spectrometry	Non-volatile	<0.1 ppm	2/78

Economic Achievability

Appendix 9

of the

Development Document

BEST AVAILABLE TECHNOLOGY ASSESSMENTS
ADDITIONAL INFORMATION

As stated in Chapter 4, three sets of limit options were defined as follows:

- Option #1: Best In North America (in general, Best In The World)
- Option #2: Best Metals Removal
- Option #3 Zero Discharge (Zero Volume Discharge)

The technology trains that make up the above options are discussed in the consultant's report entitled "Best Available Pollution Control Technology: Metal Mining Sector: December 1991: Second Edition, June 1992: Kilborn Inc./Environmental Applications Group Ltd.". Design criteria and capital and operating costs are given in substantial detail for best available technologies and for the technology that permits zero volume discharge. Costs are expressed in fourth quarter 1991 Canadian dollars.

Since the Metal Mining Sector limits regulation applies only to operating metal mines and only to mines discharging total effluent volumes of more than 50 cubic meters (11,000 gallons) per day, the regulation is expected to have little impact on small mines and on exploration/development activities.

The following observations were made in the consultant's BAT report:

- For many Ontario mines, discharge concentration levels are currently comparable to effluent concentration levels:

  (a) from BAT plants anywhere in the world where conditions are similar to those in Ontario

  (b) stated by the U.S. EPA for the sector

  (c) produced by any demonstated technology within the industry that advances the sector towards the MISA goal

  Most gold and base metal mines in Ontario are already producing effluents that are among the cleanest in the world (when compared to like effluents from like properties). This is due to the fact that, since MISA began in 1986, a large number of Ontario mines installed "leading edge" technologies that make use of substances such as sulphur dioxide, hydrogen peroxide and carbon dioxide.

- The highly variable nature of ore ("ore" is an economic definition) makes it impossible to identify a specific

BAT option which can be used by all mines or even most mines in a specific subsector. As a consequence, the consultant identified a large number of technology trains that are currently in place in Ontario. Each of these trains is believed to result in similar final concentrations of contaminants , essentially reducing emissions to a level at or below current U.S. EPA limits for the sector.

- Due to the significant and unpredictable variability in ore compositions and mining and milling methods and technologies and site limiting geographic features, it is impossible to predict what final concentrations or loadings would result from any given technology train at any given mine. As a consequence, a generic approach to costing different BAT options was used although, ultimately, detailed costing can only be done on a site-by-site basis using site-specific information.

The following includes specific results of the economic analysis done on the Ontario metal mining sector:

Sector Overview

- 50 metal mines
- 27,000 employees
- Most employment in northern Ontario
- Mine 100,000 tonnes of ore per day
- Sector practices significant re-use of wastewater
- Discharge 153,000,000 gallons of wastewater per day

Current Economic Conditions

- 1990 saw large losses for many of the firms
- 1991 performance shows improvement
- The mining industry was the leader on the "save our north" campaign, which called upon the Ontario government to promote and strengthen northern based activities
  - The government of Ontario has committed itself to assisting the mining industry
  - Currently, new incentives are being examined which will encourage exploration and development

Economic Outlook

- Over the short term metal prices are expected to continued their downward trend in all subsectors (except iron ore)

- Major factors include:
  - increased world production/output
  - surplus stocks inventories
  - economic downturn in western world markets

- From 1989-1991 exploration spending has declined from $1.35B to $650M and the trend is expected to continue until metal prices begin to increase

- Growth in the metal mining industry is not expected until the medium term (3-5 yrs) when world economies are forecast to experience sustained economic growth

Sources: 1991 Canadian Minerals Yearrbook.
Globe and mail, August 1992

Limit Options Considered

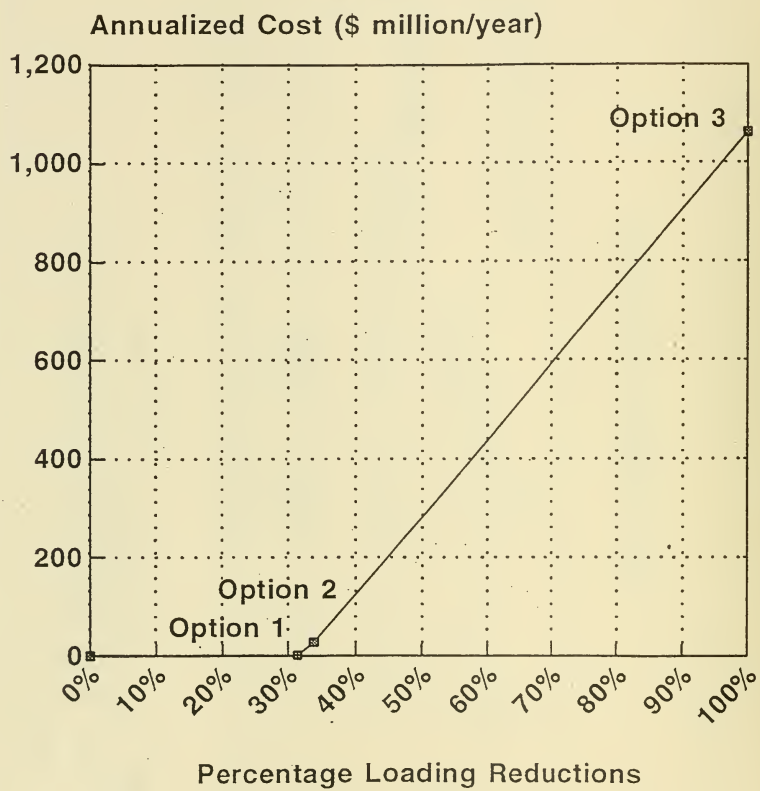
- Option #1 Best in North America
- Option #2 Maximum Technically Achieveable
- Option #3 Zero Discharge

Limit Options Summary

OPTIONS	Costs			Total Loading Reductions and Cost Per kg Removed		
	Capital $000's/yr	Operating $000's/yr	After-tax Annualized $ 000's/yr	Total Contaminant Reductions	Percentage Reductions	Cost Per kg Removed
Limit Option 1	$9,780	$2,262	$2,396	614,770	31.4%	$3.90
Limit Option 2	$180,338	$16,184	$28,861	661,023	33.8%	$43.66
Limit Option 3	$511,600	$1,680,000	$1,062,327	1,957,028	100.0%	$542.83

Total contaminants = Conventionals + EMPPL Priority
Conventionals = Total Suspended Solids
EMPPL = Copper, Nickel, Lead, Zinc, Arsenic, Cyanide

Abatement Cost Function
All Regulated Contaminants



Regulated Contaminants:
TSS, Copper, Nickel, Lead, Zinc, Arsenic, Cyanide

Summary of Regulatory Options

OPTION I:

- Most cost-effective option ($3.9/kg removed)
- Reduces conventionals by 31%
- Reduces non-conventionals by 39%
- Accepted by industry representatives

OPTION II:

- Increase cost by $26 million annually
- No additional reduction in conventionals
- Reduces non-conventionals by another 26%

OPTION III:

- 100% reduction of all parameters
- Over $1 billion annual cost

Environmental Benefits

- The 3 options under consideration will reduce contaminant loadings by 30 to 100%.

- Receiving waters in mining areas will be less toxic, less turbid and more useable for fishing, drinking and swimming.

Technology train options postulated at each plant were designed so that each type of technology combination option would achieve the same final concentration of each of the seven contaminants to be limited at each plant in the sector. Three different technology train options were specified at each plant/mine site so that only three sets of costs and final loading estimates were available for each plant. The contaminant concentration values specified for each technology train option were also the proposed limits options.

Two levels of concentration values were based on levels achieved at similar mines/plants in Ontario or elsewhere in the world. Another technology/limit option of effluent evaporation was postulated for perspective. It should be noted that, at some mining sites, there are technology combinations that could achieve contaminant concentration and loading levels that are higher or lower than the levels analyzed below. The table below summarizes the three limit options.

Concentration Limit Options for the Metal Mining Sector

Parameters	Best In North America Option	Best Metals Removal Option	Forced Evaporation Option
Total Suspended Solids (mg/litre)	15	15	0
Lead (mg/litre)	0.2	0.1	0
Copper (mg/litre)	0.3	0.1	0
Nickel (mg/litre)	0.5	0.1	0
Zinc (mg/litre)	0.5	0.1	0
Arsenic (mg/litre)	0.5	0.5	0
Total Cyanide (mg/litre)	1.0	1.0	0
pH range	6.0 to 9.5		
Toxicity	Non-acutely Lethal		

The Use of Concentrations and Loadings

in the

Metal Mining Sector

Appendix 10

of the

Development Document

THE USE OF CONCENTRATIONS AND LOADINGS

METAL MINING SECTOR

The MISA document published in June of 1986 and known as the "White Paper" indicated that the performance level for defined technologies "will be established in units of concentration (mg/l) and either mass loading (kg/day) or load per unit of production (kg/day/production unit)".

For at least the last 23 years in Ontario, requirements placed on mines in the Metal Mining Sector as outlined in published Ministry documents have been largely based on the use of concentrations as the main control mechanism. In exceptional circumstances, loading limits have been placed on mines operating in sensitive areas. These loadings have normally been developed on a site-specific basis.

Internationally, the control mechanism of choice for metal mining effluents is concentration-based guidelines or regulations. This statement applies to Provincial, Regional, State and Federal agencies of Canada, the United States, Australia, New Zealand, Spain, Italy, Finland, Sweden, Germany and France.

Internationally, in metal mining, effluents are limited using concentrations rather than loadings for the following general reasons:

(1) Under normal operating circumstances, it is concentrations and not loadings that are responsible for most observable short-term environmental problems in a receiving stream associated with any particular metal mining sector effluent.

(2) Errors that are made when concentrations are determined are largely due to sampling and analytical problems. Errors associated with analysis can be kept to very low levels when care is taken. Similarly, errors due to sampling techniques can often be minimized. The calculation of loadings, on the other hand, is dependent on accurate flow measurement. When flows are low, the error associated with flow measurement can be correspondingly low (usually less than plus or minus 5 per cent). When flows are high, errors due to flow measurement tend to increase. In the Ontario Metal Mining Sector, for example, effluent flows are commonly in excess of 4,500 cu. meters/day (1,000,000 gallons/day) with the largest documented flow being over 200,000 cu. meters/day (44,000,000 gallons/day). At these flow rates, errors of plus or minus 10 per cent can be expected and, in fact, the Ontario Metal Mining Sector Effluent Monitoring Regulation acknowledged problems due to the measurement of high flow volumes in remote locations indicating that such flows were to be measured or estimated (at the time of sampling) to within an accuracy of plus or minus 20 per cent. Any subsequent loading calculations involve all errors of

sampling, analysis and flow measurement. The determination of concentrations does not involve flow and the errors associated with flow measurement.

(3) With some exceptions, most environmental problems that occur in receiving waters as a result of the operations of metal mines are not due to large amounts of various materials being discharged to the receiving water but, instead, are due to the sensitive nature of the receiving water itself. For example, in Ontario, most shield lakes are very pure, the water is very soft and most have a very limited ability to assimilate wastes. In addition, most metal mining effluents contain substances that are inorganic in nature and do not degrade to any reasonable extent. These substances, such as copper, tend to accumulate in a receiver and, over a period of time, can exert a definite and observable impact on the sediments, flora and fauna of the receiver. In the short term, very small concentrations of substances such as copper can kill or damage lifeforms in the receiver. This can be demonstrated using bioassay techniques.

(4) Under normal operating circumstances, total loadings from metal mines tend to be low. For example, in 1991, the total daily loadings for all mines in the (Ontario) Metal Mining Sector for the four most commonly mined base metals were as follows:

copper	103 kg/day
nickel	162 kg/day
lead	4 kg/day
zinc	112 kg/day

At many mines, the individual daily loadings of these substances are only a few grams per day.

(5) In general, in metal mining, there is no consistent correlation between flow and production. In particular, there is no consistent correlation between production and effluent loadings.

In the Metal Mining Sector, it is very difficult to relate loadings to "units of production" since there are no "units of production" within the sector that are consistent enough to permit a practical sector-wide linkage of loadings and production. For example, TONNES OF ORE MINED seems to be a logical "unit of production" and it seems that a loading restriction might reasonably be based on this. As an example, copper in an effluent could be limited to 0.1 grams of copper per tonne of ore mined. The problem with this approach is that "ore" itself is not a standard unit but is essentially an economic definition. No two ores are alike and of equal value. Ore becomes ore when it can be extracted at a profit. 500 tonnes of one copper ore can yield as much copper as 5,000 tonnes of another copper ore. In the example of the copper loading restriction given above, the 500 tonne operation would be allowed to discharge 50 grams of copper (per day) and the 5,000 tonne operation would be allowed to discharge 500 grams per day. This seems to be reasonable until you remember that both operations are mining the same amount

of copper. There is also the problem of the different types of mines that can be involved. In general, ore can be mined underground or in open pits. The mining methods are quite different in most cases and in most cases yield different amounts of waste material. For example, if we assume that two copper mines are in operation and that both are mining an identical ore at the rate of 5,000 tonnes per day, it would again appear reasonable to apply the same loading restriction (0.1 grams of copper per tonne of ore) to each operation and to allow each operation to discharge (as a maximum) the same amount of copper. However, other factors that impact on the environment exist even in this situation. For example, the amount of waste rock that has to be removed at an open pit in order to permit the extraction of the ore varies but averages about 2.5 tonnes per tonne of ore. In other words, at the 5,000 tonne per day open pit operation, in order to extract the 5,000 tonnes of copper ore, another 12,500 tonnes of waste rock (which may contain leachable copper values) will have to be removed from the pit and disposed of. Underground operations do have to remove waste material under a variety of circumstances and waste does become incorporated into the ore (a process called dilution) but the amount of waste normally involved is small when compared to an open pit operation.

If "tonnes of ore mined" cannot be used as a standard "unit of production", then perhaps TONNES OF ORE MILLED could be used as a standard "unit of production". Again, many problems arise. We have already seen that not all material mined under all circumstances is milled (waste rock from an open pit is usually not milled). Adding to this problem is the varying nature of the ores in the Metal Mining Sector itself. Gold mining, for example, may give rise to more tailings than ore milled. This is because each tonne of gold ore usually yields only a few grams of gold. All the rest of the material becomes tailings and, added to the tailings are some of the chemicals and substances that are used to recover the gold (such as lime). Iron mines, on the other hand, may recover between 25 and 40 per cent (as iron concentrate) of material entering a mill, uranium mines may recover approximately one kilogram of material from each tonne of ore and the copper, nickel, lead and zinc mines can recover a small to a medium percentage of ore milled as product. The end result of all of this is that even when metal mines mill identical amounts of ore, identical amounts of tailings are not produced in all cases. Further complicating this situation is the fact that not all tailings produced in a mill are disposed of in a tailings area. It is common practice in the Metal Mining Sector (in particular: underground mines) to use a substantial amount of tailings in the mining process itself (as backfill). The amount of backfill that will be used at any particular mine is difficult to predict and will depend on local geological conditions, the mining methods being employed and also on the metallurgy of the ore itself. If very fine grinding is required in a mill to liberate ore values, only a small amount of material that is suitable for backfill may be produced. In this case, backfill requirements may be only partially produced by the mill and local sources of backfill (such as sand and gravel) may have to be

utilized.

Relating loadings to "units of production" within the Metal Mining Sector is also complicated by the fact that the chemical nature of the ores mined and the tailings produced within the sector varies greatly. For example, some iron ores (taconites) that have been mined in Ontario are almost completely inert and present few significant environmental problems. Uranium ores are radioactive and some produce acid. Many base metal ores contain substantial quantities of acid-producing substances along with metals. Other ores contain substances such as arsenic, mercury and mineral fibres.

Relating loadings to "units of production" within the Metal Mining Sector can be complicated by the fact that, in some cases, TONNES OF ORE MINED and TONNES OF ORE MILLED are not directly associated and are somewhat unpredictable. Custom mills, for example, are set up to mill quantities of ore that have been mined in various locations by different individuals or companies. Adding to this problem is the fact that, within the Metal Mining Sector, some properties have either no mill or no mine or no operating mine or mill making it difficult again to relate loadings to "units of production".

Tailings disposal (that is, the operation of a tailings area) might be considered to be a "unit of production". As a consequence, some attempt might be made to relate loadings to TONNES OF TAILINGS entering a tailings area, tonnes of tailings within a tailings area, the surface area of a tailings area or the length or height of tailings dams and so forth. Since we have already seen that the tonnes of tailings leaving a mill (if a mill exists on the property---some properties have no mill or tailings area) is difficult to predict and depends on factors such as the nature and grade of the ore, the mining methods being used and the metallurgy being employed, a direct link between tailings disposal and loadings is difficult to generate. Any attempt to link the surface area or dam length or dam height of a tailings area to loadings may indeed encourage the construction of disposal areas that feature small surface areas and high dams. In addition, it has already been noted that tailings within a tailings area may be almost inert or may be highly reactive.

(6) Any attempt to relate loadings to "units of production" of necessity involves the acquisition of accurate production data on a continuing basis from the mining properties involved. If the production data are not accurate or cannot be verified on a continuing basis, the resulting loading limits have little meaning. Concentration limits are independent of flow and do not involve a need to acquire accurate production data on a continuing basis.

(7) The use of MASS LOADINGS is usually suggested when loadings cannot be related to "units of production". Mass loadings are generally most useful when they are related to receiving water quality criteria or considerations. For example, if a metal mine

discharges an effluent at a volume of 4,500 cu. meters/day (1,000,000 gallons per day) to a receiver that contains 25 parts per billion of copper (from natural sources), it seems reasonable to assume that an effluent copper concentration of 25 parts per billion (loading equivalent: 114 grams) could be tolerated with no significant short-term impact on the receiver. However, there are problems with this type of approach. The most significant problem is that it is likely that the mine intake water already contains 25 parts per billion copper (from natural sources) and, assuming that nothing happens to the copper during its stay in the mine or mill, any effluent water produced will already contain the allowable amount of copper. Any decision to increase the allowable amount of copper in the effluent (for example: to 50 parts per billion) would be arbitrary and arbitrary decisions should be avoided if possible.

(8) In the Metal Mining Sector, it is difficult to relate loadings to suggested performance levels of defined technologies. Each ore, mine and mill is different. A technology that will perform well at one mining property may fail completely at an adjacent property. Most metal ores contain at least traces of a variety of metals and other substances. Since no two ores are alike, technologies have to be evaluated on a site-specific basis. A further difficulty arises with regard to the efficiency of a tailings area as a settling device. Tailings normally arrive at a tailings area in the form of a slurry containing approximately 45 per cent solids. Whether the effluent from the area contains 15 mg/litre of suspended solids or 10 mg/litre of suspended solids, the area is operating at essentially 100 per cent efficiency.

Remark Codes

Number of Data Points Used in Reporting

Appendix 11

of the

Development Document

Remark Codes

Remark Code	Description	Number of Data Points
	No remark code entered	38041
<	Actual amount less than reported	644
<DL	Reported value = MDL: measured amt. MDL (non-zero)	31277
<T	A measurable trace amount: interpret with caution	15
<W	No measurable response (zero): reported value	825
<WE	No measurable response (diln/conc): reported value	43
A	Approximate value	97
AIS	Approximate value	9
AR	Attached report	28
I	Interference suspected	5
IM	Interference matrix	12
N/A	No data will be reported	1838
OLD	Old: samples exceeds maximum storage time	153
SIP	Sample improperly preserved	1
UCR	Data unreliable: could not confirm by reanalysis	8
UQC	Data unreliable: possible lab QC problem(s)	4
?	Late data: data not yet available: see text	44
|IN	No data: insufficient volume due to inspection	1
|NM	No effluent - no sample will be reported	2608
Total Number of Data Points for SR, PR or MW Effluents →		75653

Total Number of Data Points Used in Reporting for SR, PR and MW Effluents

Remark Code	Number of Data Points	% of Total
No Remark	38000	53.42
<	644	.91
<DL	31277	43.97
<T	15	.02
<W	825	1.16
<WE	43	.06
A	97	.14
AIS	9	.01
AR	28	.02
I	5	<.01
IM	12	.02
N/A	4	<.01
OLD	153	0.21
¦NM	1	<.01
?	44	.06
	Total →	100%

Site Performance Data

Appendix 12

of the

Development Document

Site Performance Data: pH — 12 – Month Monitoring Data
MISA Metal Mining Sector — February 1, 1990 to January 31 1991

Company	Cmpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156		9.983	9.983	10.604	1.062	1.022	10.604	10.199
02 – INCO, Crean Hill Mine	MW 0100	157		9.948	9.948	12.014	1.208	1.069	12.013	10.639
03 – Falconbridge, Falconbridge	PR 0100	156		6.786	6.786	7.737	1.14	1.048	7.737	7.11
04 – INCO, Garson Mine	MW 0100	157		10.093	10.094	11.498	1.139	1.047	11.498	10.571
05 – Noranda Minerals, Geco Division	PR 0100	142		9.237	9.237	9.955	1.078	1.027	9.955	9.485
06 – Falconbridge, Kidd Creek Mine	MW 0100	148		10.785	10.786	13.069	1.212	1.071	13.068	11.547
07 – INCO, Levack Mine	MW 0100	148		9.427	9.427	13.29	1.41	1.145	13.29	10.793
08 – Falconbridge, Lockerby	MW 0100	155		7.36	7.359	8.691	1.181	1.061	8.691	7.808
09 – Falconbridge, Metallurgical	PR 0100	157		10.916	10.917	13.225	1.211	1.071	13.224	11.687
10 – INCO, Refinery, Sudbury	SR 0100	157		9.913	9.914	11.008	1.11	1.038	11.008	10.289
11 – INCO, Nolin Creek T.P.	SW 0100	12		10.018	10.019	11.478	1.146	1.049	11.476	10.513
12 – Falconbridge, Onaping	MW 0100	155		9.804	9.804	11.05	1.127	1.043	11.05	10.229
13 – INCO, Refinery, Port Colborne	SR 0100	155		10.357	10.357	11.354	1.096	1.033	11.354	10.7
14 – INCO, Shebandowan Mine	PR 0100	153		7.382	7.383	8.137	1.102	1.035	8.137	7.642
15 – Falconbridge, Strathcona	PR 0100	156		7.805	7.804	10.953	1.404	1.129	10.955	8.814
16 – INCO, Whistle Mine	MW 0100	89		8.998	9.004	14.315	1.59	1.182	14.305	10.638
17 – Minnova, Winston Lake Mine	PR 0100	101		7.866	7.867	10.007	1.272	1.09	10.007	8.571
19 – Dickenson, Arthur W. White Mine	PR 0100	136		7.496	7.496	8.073	1.077	1.027	8.073	7.696
21 – Canamax, Bell Creek Mine	PR 0100	42		7.476	7.476	7.899	1.057	1.02	7.899	7.623
24 – Teck – Corona, David Bell Mine	PR 0100	110		7.44	7.44	7.799	1.048	1.017	7.799	7.565
25 – Placer Dome, Detour Lake Mine	PR 0100	157		7.426	7.426	8.37	1.127	1.043	8.37	7.748
26 – Placer Dome, Dome Mine	PR 0100	78		7.482	7.482	8.114	1.084	1.029	8.114	7.7
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmaque Gold Mines	PR 0100	156		7.022	7.022	7.739	1.102	1.035	7.739	7.268
29 – Giant Yellowknife, ERG Res.	PR 0100	18		7.327	7.328	8.016	1.094	1.032	8.016	7.564
30 – Hemlo Gold Mines, Golden Giant	PR 0100	69		7.628	7.628	8.4	1.101	1.084	8.4	8.272
31 – Canamax, Kremzar Mine	PR 0100	47		7.464	7.464	11.96	1.602	1.077	11.96	8.038
32 – LAC Minerals, Macassa Division	PR 0100	158		7.734	7.734	8.377	1.083	1.029	8.377	7.956
35 – Canamax, Marhill Mine	MW 0100	156		8.119	8.119	8.593	1.058	1.02	8.593	8.284
36 – American Barrick, McDermott	PR 0100	22		7.12	7.121	7.512	1.055	1.019	7.512	7.257
37 – Bond Gold, Muskegsagagagen Lake	PR 0100	135		7.043	7.043	7.68	1.09	1.031	7.68	7.262
38 – LAC Minerals, Williams Mine	MW 0100	24		9.564	9.564	10.517	1.1	1.034	10.516	9.891
38 – LAC Minerals, Williams Mine	PR 0200	65		7.709	7.709	8.049	1.044	1.015	8.049	7.828
39 – Giant Yellowknife, Pamour #1	PR 0100	116		7.717	7.717	9.198	1.192	1.064	9.198	8.211
39 – Giant Yellowknife, Pamour #1	PR 0200	22		7.325	7.326	7.863	1.073	1.025	7.863	7.512
40 – Giant Yellowknife, P–S	MW 0100	16		7.785	7.785	8.278	1.063	1.022	8.278	7.956
42 – Renabie Gold Mines	PR 0100	85		8.141	8.141	9.321	1.145	1.049	9.321	8.542
45 – St. Andrews Gold Fields	PR 0100	61		7.844	7.844	9.73	1.241	1.087	9.73	8.53
46 – Algoma Steel, Ore Division	PR 0100	76		8.717	8.722	12.672	1.453	1.144	12.664	9.968
51 – Denison Mines, Denison Property	PR 0100	158		7.518	7.518	9.377	1.247	1.082	9.378	8.135
51 – Denison Mines, Denison Property	SW 0200	12		7.208	7.209	7.924	1.099	1.034	7.923	7.454
52 – Rio Algom, Lacnor/Nordic	SW 0100	12		8.397	8.398	9.616	1.145	1.049	9.615	8.81
53 – Rio Algom, Panel	SR 0100	145		7.824	7.827	10.199	1.303	1.099	10.195	8.6
54 – Rio Algom, Pronto	SW 0100	6		8.833	8.833	10.943	1.239	1.084	10.943	9.579
55 – Rio Algom, Quirke	PR 0100	147		7.592	7.593	9.195	1.211	1.07	9.194	8.127
56 – Cameco, Refinery, Blind River	SR 0300	97		7.389	7.389	8.649	1.171	1.06	8.649	7.834
57 – Cameco, Refinery, Port Hope	SR 0100	101		8.142	8.142	8.821	1.083	1.029	8.821	8.376
57 – Cameco, Refinery, Port Hope	SR 0200	102		8.155	8.155	8.756	1.074	1.026	8.756	8.363
57 – Cameco, Refinery, Port Hope	SR 0300	103		8.136	8.136	8.61	1.058	1.05	8.61	8.546
58 – Rio Algom, Stanleigh	SR 0100	144		7.529	7.528	9.232	1.226	1.075	9.232	8.096
59 – Denison Mines, Stanrock	SW 0100	12		7.942	7.946	10.448	1.315	1.103	10.442	8.758

Site Performance Data: **Total Suspended Solids** **12 – Month Monitoring Data**
MISA Metal Mining Sector February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	155	10	18.252	18.085	73.989	4.091	1.78	74.67	32.492
02 – INCO, Crean Hill Mine	MW 0100	157	114	3.548	3.54	9.889	2.793	1.405	9.91	4.985
03 – Falconbridge, Falconbridge	PR 0100	156	45	3.747	3.676	12.778	3.476	1.635	13.025	6.127
04 – INCO, Garson Mine	MW 0100	157	7	9.255	9.135	26.382	2.888	1.505	26.729	13.933
05 – Noranda Minerals, Geco Division	PR 0100	142	52	15.134	14.906	65.155	4.371	1.858	66.152	28.123
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	19	7.387	7.249	38.45	5.304	2.046	39.184	15.114
07 – INCO, Levack Mine	MW 0100	148	23	17.52	17.382	111.279	6.402	2.276	112.164	39.88
08 – Falconbridge, Lockerby	MW 0100	155	76	2.413	2.413	7.88	3.266	1.388	7.88	3.349
09 – Falconbridge, Metallurgical	PR 0100	155	3	12.178	12.268	72.255	5.89	2.165	71.726	26.36
10 – INCO, Refinery, Sudbury	SR 0100	157	59	4.204	4.18	9.557	2.286	1.348	9.611	5.665
11 – INCO, Nolin Creek T.P.	SW 0100	12	0	29.5	30.799	182.887	5.936	2.174	175.173	64.144
12 – Falconbridge, Onaping	MW 0100	155	13	8.763	8.792	26.049	2.963	1.518	25.963	13.303
13 – INCO, Refinery, Port Colborne	SR 0100	152	26	7.072	6.936	22.802	3.288	1.602	23.252	11.329
14 – INCO, Shebandowan Mine	PR 0100	153	96	4.235	4.158	14.644	3.522	1.586	14.917	6.716
15 – Falconbridge, Strathcona	PR 0100	156	51	3.819	3.539	21.575	6.097	2.181	23.284	8.328
16 – INCO, Whistle Mine	MW 0100	88	7	11.182	11.073	45.601	4.118	1.781	46.05	19.913
17 – Minnova, Winston Lake Mine	PR 0100	100	31	11.975	11.779	56.449	4.792	1.913	57.39	22.911
19 – Dickenson, Arthur W. White Mine	PR 0100	136	43	8.213	8.185	20.924	2.556	1.429	20.995	11.735
21 – Canamax, Bell Creek Mine	PR 0100	42	5	7.167	7.384	33.164	4.491	1.877	32.187	13.455
24–TECK		110	78	1.018	1.018	6.268	6.16	1.83	6.268	1.862
25 – Placer Dome, Detour Lake Mine	PR 0100	157	97	6.441	6.312	23.77	3.766	1.616	24.255	10.411
26 – Placer Dome, Dome Mine	PR 0100	78	52	6.205	6.19	15.719	2.539	1.37	15.757	8.5
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmeque Gold Mines	PR 0100	156	77	11.962	11.488	65.706	5.719	2.098	68.413	25.093
29 – Giant Yellowknife, ERG Res.	PR 0100	18	5	9.167	9.17	21.222	2.314	1.397	21.215	12.809
30 – Hemlo Gold Mines, Golden Giant	PR 0100	70	23	11.885	11.424	65.848	5.764	2.117	68.502	25.165
31 – Canamax, Kremzar Mine	PR 0100	47	26	3.309	3.237	18.046	5.575	2.036	18.444	6.737
32 – LAC Minerals, Macassa Division	PR 0100	158	50	9.69	9.52	30.791	3.234	1.583	31.34	15.344
35 – Canamax, Marhill Mine	MW 0100	156	0	153.058	170.665	1146.56	6.718	2.351	1028.27	359.67
36 – American Barrick, McDermott	PR 0100	22	0	2.909	2.909	8.644	2.971	1.52	8.644	4.422
37 – Bond Gold, Muskegsagagagen Lake	PR 0100	135	47	4.234	4.178	15.655	3.747	1.697	15.865	7.184
38 – LAC Minerals, Williams Mine	MW 0100	24	0	16.583	16.614	29.72	1.789	1.236	29.666	20.497
38 – LAC Minerals, Williams Mine	PR 0200	65	23	1.324	1.289	4.9	3.8	1.687	5.033	2.235
39 – Giant Yellowknife, Pamour #1	PR 0100	116	38	16.276	14.591	81.211	5.566	2.084	90.59	33.925
39 – Giant Yellowknife, Pamour #1	PR 0200	22	0	27.318	27.836	99.153	3.562	1.651	97.308	45.116
40 – Giant Yellowknife, P–S	MW 0100	16	13	7.5	7.718	41.663	5.398	2.005	40.485	15.041
42 – Renabie Gold Mines	PR 0100	85	3	4.504	4.63	18.909	4.084	1.76	18.392	7.928
45 – St. Andrews Gold Fields	PR 0100	61	2	22.698	22.242	103.323	4.645	1.895	105.443	43.007
46 – Algoma Steel, Ore Division	PR 0100	78	7	8.274	8.746	51.507	5.889	2.168	48.73	17.936
51 – Denison Mines, Denison Property	PR 0100	158	21	7.777	7.735	19.533	2.525	1.426	19.638	11.088
51 – Denison Mines, Denison Property	SW 0200	12	9	4.3	4.3	7	1.628	1.209	7	5.2
52 – Rio Algom, Lacnor/Nordic	SW 0100	12	0	3.4	3.67	25.642	6.987	2.413	23.755	8.204
53 – Rio Algom, Panel	SR 0100	145	0	3.315	3.369	13.666	4.057	1.76	13.449	5.834
54 – Rio Algom, Pronto	SW 0100	6	0	2.15	2.256	10.977	4.867	1.937	10.463	4.164
55 – Rio Algom, Quirke	PR 0100	147	0	3.206	3.205	9.821	3.064	1.541	9.825	4.941
56 – Cameco, Refinery, Blind River	SR 0300	97	0	34.278	34.556	126.915	3.673	1.676	125.897	57.445
57 – Cameco, Refinery, Port Hope	SR 0100	100	34	18.59	17.895	118.887	6.644	2.314	123.503	43.016
57 – Cameco, Refinery, Port Hope	SR 0200	102	26	32.551	17.079	121.337	7.105	2.418	231.264	78.692
57 – Cameco, Refinery, Port Hope	SR 0300	101	31	17.495	17.101	95.851	5.605	2.1	98.062	36.746
58 – Rio Algom, Stanleigh	SR 0100	144	0	10.305	10.456	28.126	2.69	1.456	27.72	15.003
59 – Denison Mines, Stanrock	SW 0100	12	4	4.917	4.93	9.08	1.842	1.233	9.056	6.064

Site Performance Data: Copper — 12 – Month Monitoring Data
MISA Metal Mining Sector — February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156	0	0.208	0.209	0.572	2.744	1.468	0.572	0.306
02 – INCO, Crean Hill Mine	MW 0100	157	90	0.009	0.009	0.031	3.679	1.621	0.033	0.015
03 – Falconbridge, Falconbridge	PR 0100	156	39	0.015	0.014	0.072	5.006	1.963	0.075	0.029
04 – INCO, Garson Mine	MW 0100	157	84	0.013	0.013	0.067	5.288	2.004	0.071	0.027
05 – Noranda Minerals, Geco Division	PR 0100	142	1	0.181	0.182	0.743	4.085	1.768	0.741	0.321
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	1	0.053	0.051	0.189	3.689	1.682	0.196	0.089
07 – INCO, Levack Mine	MW 0100	148	35	0.024	0.021	0.126	6.133	2.209	0.145	0.052
08 – Falconbridge, Lockerby	MW 0100	154	70	0.011	0.01	0.054	5.525	2.039	0.062	0.023
09 – Falconbridge, Metallurgical	PR 0100	157	11	0.375	0.216	2.937	13.569	3.808	5.084	1.427
10 – INCO, Refinery, Sudbury	SR 0100	157	3	0.112	0.114	0.639	5.62	2.105	0.632	0.237
11 – INCO, Nolin Creek T.P.	SW 0100	12	1	0.724	0.851	9.888	11.623	3.455	8.417	2.502
12 – Falconbridge, Onaping	MW 0100	154	81	0.011	0.011	0.065	6.042	2.151	0.067	0.024
13 – INCO, Refinery, Port Colborne	SR 0100	153	0	0.168	0.175	0.962	5.513	2.08	0.925	0.349
14 – INCO, Shebandowan Mine	PR 0100	154	134	0.007	0.007	0.021	3.186	1.489	0.022	0.01
15 – Falconbridge, Strathcona	PR 0100	156	28	0.023	0.021	0.119	5.76	2.133	0.133	0.049
16 – INCO, Whistle Mine	MW 0100	89	3	0.07	0.075	0.543	7.239	2.469	0.509	0.173
17 – Minnova, Winston Lake Mine	PR 0100	100	12	0.023	0.022	0.068	3.063	1.548	0.07	0.035
19 – Dickenson, Arthur W. White Mine	PR 0100	136	0	0.494	0.492	0.945	1.921	1.27	0.949	0.627
21 – Canamax, Bell Creek Mine	PR 0100	3	0	0.267	0.269	0.447	1.664	1.203	0.444	0.321
24 – Teck – Corona, David Bell Mine	PR 0100	110	46	0.014	0.011	0.071	6.662	2.299	0.096	0.033
25 – Placer Dome, Detour Lake Mine	PR 0100	157	0	0.313	0.314	0.628	2.001	1.291	0.627	0.404
26 – Placer Dome, Dome Mine	PR 0100	78	0	0.262	0.26	0.717	2.762	1.472	0.723	0.385
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmaque Gold Mines	PR 0100	156	111	0.015	0.015	0.189	12.68	2.635	0.189	0.039
29 – Giant Yellowknife, ERG Res.	PR 0100									
30 – Hemlo Gold Mines, Golden Giant	PR 0100	70	14	0.03	0.027	0.113	4.208	1.8	0.126	0.054
31 – Canamax, Kremzar Mine	PR 0100	5	2	0.041	0.041	0.176	4.252	1.993	0.176	0.083
32 – LAC Minerals, Macassa Division	PR 0100	158	2	0.264	0.295	3.146	10.666	3.275	2.818	0.865
35 – Canamax, Marhill Mine	MW 0100	12	5	0.014	0.014	0.055	3.944	1.781	0.054	0.025
36 – American Barrick, McDermott	PR 0100	22	0	0.1	0.1	0.271	2.721	1.463	0.272	0.147
37 – Bond Gold, Muskegsagagagen Lake	PR 0100									
38 – LAC Minerals, Williams Mine	MW 0100	24	0	0.01	0.01	0.02	1.865	1.256	0.02	0.013
38 – LAC Minerals, Williams Mine	PR 0200	65	2	0.043	0.04	0.226	5.676	2.117	0.244	0.091
39 – Giant Yellowknife, Pamour #1	PR 0100	116	42	0.091	0.071	0.764	10.825	3.202	0.98	0.29
39 – Giant Yellowknife, Pamour #1	PR 0200	22	17	0.019	0.019	0.109	5.791	2.171	0.109	0.041
40 – Giant Yellowknife, P–S	MW 0100	16	1	0.215	0.215	0.428	1.992	1.38	0.428	0.297
42 – Renabie Gold Mines	PR 0100	8	0	0.32	0.336	1.164	3.464	1.63	1.109	0.522
45 – St. Andrews Gold Fields	PR 0100	5	0	0.144	0.152	0.471	3.101	1.549	0.448	0.224
46 – Algoma Steel, Ore Division	PR 0100									
51 – Denison Mines, Denison Property	PR 0100	12	3	0.009	0.009	0.061	6.865	2.369	0.062	0.022
51 – Denison Mines, Denison Property	SW 0200	12	9	0.006	0.01	0.141	14.747	3.855	0.093	0.024
52 – Rio Algom, Lacnor/Nordic	SW 0100	12	5	0.012	0.012	0.02	1.722	1.388	0.02	0.016
53 – Rio Algom, Panel	SR 0100	12	3	0.015	0.015	0.039	2.628	1.43	0.039	0.021
54 – Rio Algom, Pronto	SW 0100	6	1	0.018	0.019	0.046	2.472	1.416	0.045	0.026
55 – Rio Algom, Quirke	PR 0100	12	1	0.022	0.022	0.059	2.699	1.466	0.059	0.032
56 – Cameco, Refinery, Blind River	SR 0300	9	3	0.013	0.013	0.075	5.819	2.552	0.075	0.033
57 – Cameco, Refinery, Port Hope	SR 0100	9	4	0.019	0.021	0.273	13.15	3.619	0.244	0.067
57 – Cameco, Refinery, Port Hope	SR 0200	9	2	0.009	0.01	0.075	7.752	2.565	0.072	0.024
57 – Cameco, Refinery, Port Hope	SR 0300	9	2	0.006	0.007	0.036	5.516	2.078	0.034	0.013
58 – Rio Algom, Stanleigh	SR 0100	11	1	0.017	0.018	0.048	2.75	1.469	0.048	0.026
59 – Denison Mines, Stanrock	SW 0100	12	5	0.007	0.007	0.055	8.273	2.674	0.056	0.018

Site Performance Data: **Nickel** — 12 – Month Monitoring Data
MISA Metal Mining Sector — February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156	2	0.613	0.567	2.179	3.847	1.715	2.358	1.051
02 – INCO, Crean Hill Mine	MW 0100	157	1	0.191	0.175	0.695	3.979	1.743	0.762	0.334
03 – Falconbridge, Falconbridge	PR 0100	156	0	0.316	0.32	0.74	2.311	1.367	0.73	0.432
04 – INCO, Garson Mine	MW 0100	157	1	0.534	0.489	2.734	5.585	2.095	2.983	1.119
05 – Noranda Minerals, Geco Division	PR 0100	142	123	0.016	0.016	0.06	3.804	1.817	0.06	0.029
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	138	0.01	0.01	0.018	1.787	1.175	0.018	0.012
07 – INCO, Levack Mine	MW 0100	148	0	0.983	1.177	13.304	11.307	3.424	11.118	3.367
08 – Falconbridge, Lockerby	MW 0100	154	4	0.144	0.146	0.472	3.233	1.59	0.467	0.23
09 – Falconbridge, Metallurgical	PR 0100	157	105	0.016	0.015	0.067	4.357	1.775	0.068	0.028
10 – INCO, Refinery, Sudbury	SR 0100	157	0	0.721	0.711	2.879	4.049	1.758	2.918	1.267
11 – INCO, Nolin Creek T.P.	SW 0100	12	0	2.724	3.082	27.855	9.039	2.896	24.623	7.89
12 – Falconbridge, Onaping	MW 0100	154	3	0.248	0.255	1.274	4.994	1.968	1.238	0.488
13 – INCO, Refinery, Port Colborne	SR 0100	153	0	0.185	0.187	0.633	3.394	1.614	0.627	0.298
14 – INCO, Shebandowan Mine	PR 0100	154	0	0.193	0.193	0.306	1.588	1.208	0.306	0.233
15 – Falconbridge, Strathcona	PR 0100	156	0	0.27	0.261	1.324	5.076	1.983	1.372	0.536
16 – INCO, Whistle Mine	PR 0100	89	0	2.214	2.525	27.278	10.805	3.311	23.922	7.331
17 – Minnova, Winston Lake Mine	PR 0100	100	77	0.014	0.014	0.066	4.64	1.825	0.065	0.026
19 – Dickenson, Arthur W. White Mine	PR 0100	136	0	0.557	0.557	0.813	1.46	1.163	0.813	0.647
21 – Canamax, Bell Creek Mine	PR 0100	3	0	0.277	0.278	0.426	1.529	1.165	0.423	0.322
24 – Teck – Corona, David Bell Mine	PR 0100	110	2	0.039	0.039	0.11	2.779	1.478	0.109	0.058
25 – Placer Dome, Detour Lake Mine	PR 0100	157	3	0.024	0.024	0.111	4.578	1.562	0.111	0.038
26 – Placer Dome, Dome Mine	PR 0100	78	0	0.276	0.276	0.346	1.255	1.084	0.346	0.299
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmaque Gold Mines	PR 0100	156	145	0.014	0.014	0.027	1.883	1.197	0.027	0.017
29 – Giant Yellowknife, ERG Res.	PR 0100									
30 – Hemlo Gold Mines, Golden Giant	PR 0100	70	9	0.068	0.073	0.317	4.357	1.852	0.298	0.127
31 – Canamax, Kremzar Mine	PR 0100									
32 – LAC Minerals, Macassa Division	PR 0100	158	34	0.059	0.061	0.34	5.539	2.099	0.327	0.124
35 – Canamax, Marhill Mine	MW 0100	12	0	0.049	0.049	0.17	3.44	1.625	0.167	0.079
36 – American Barrick, McDermott	PR 0100	22	0	0.005	0.005	0.018	3.294	1.592	0.018	0.008
37 – Bond Gold, Muskegsagagagen Lake	PR 0100									
38 – LAC Minerals, Williams Mine	MW 0100	24	21	0.019	0.019	0.025	1.339	1.113	0.025	0.021
38 – LAC Minerals, Williams Mine	PR 0200	65	0	0.04	0.04	0.096	2.399	1.388	0.096	0.055
39 – Giant Yellowknife, Pamour #1	PR 0100	116	11	0.12	0.104	0.795	7.644	2.555	0.915	0.306
39 – Giant Yellowknife, Pamour #1	PR 0200	22	6	0.032	0.033	0.105	3.223	1.638	0.104	0.053
40 – Giant Yellowknife, P–S	MW 0100	16	0	0.054	0.054	0.103	1.922	1.27	0.104	0.068
42 – Renabie Gold Mines	PR 0100	8	0	0.021	0.021	0.054	2.546	1.423	0.053	0.03
45 – St. Andrews Gold Fields	PR 0100	5	1	0.023	0.024	0.06	2.56	1.519	0.059	0.035
46 – Algoma Steel, Ore Division	PR 0100									
51 – Denison Mines, Denison Property	PR 0100	12	1	0.041	0.041	0.141	3.411	1.639	0.139	0.067
51 – Denison Mines, Denison Property	SW 0200									
52 – Rio Algom, Lacnor/Nordic	SW 0100	12	3	0.023	0.023	0.044	1.929	1.25	0.044	0.029
53 – Rio Algom, Panel	SR 0100	12	0	0.076	0.077	0.22	2.834	1.489	0.216	0.113
54 – Rio Algom, Pronto	SW 0100	6	3	0.021	0.021	0.047	2.248	1.291	0.046	0.026
55 – Rio Algom, Quirke	PR 0100	12	0	0.081	0.083	0.221	2.681	1.454	0.218	0.118
56 – Cameco, Refinery, Blind River	SR 0300									
57 – Cameco, Refinery, Port Hope	SR 0100									
57 – Cameco, Refinery, Port Hope	SR 0200									
57 – Cameco, Refinery, Port Hope	SR 0300									
58 – Rio Algom, Stanleigh	SR 0100	11	0	0.056	0.057	0.157	2.772	1.475	0.155	0.083
59 – Denison Mines, Stanrock	SW 0100	12	9	0.015	0.015	0.023	1.506	1.114	0.023	0.017

Site Performance Data: **Lead** — 12 – Month Monitoring Data
MISA Metal Mining Sector — February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156	131	0.019	0.019	0.244	12.513	3.005	0.244	0.059
02 – INCO, Crean Hill Mine	MW 0100	157	147	0.016	0.016	0.033	2.133	1.253	0.033	0.02
03 – Falconbridge, Falconbridge	PR 0100									
04 – INCO, Garson Mine	MW 0100	157	140	0.015	0.015	0.029	1.898	1.148	0.029	0.018
05 – Noranda Minerals, Geco Division	PR 0100	135	120	0.018	0.018	0.04	2.244	1.278	0.04	0.023
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	85	0.004	0.004	0.03	6.613	1.831	0.03	0.008
07 – INCO, Levack Mine	MW 0100	148	142	0.015	0.015	0.026	1.731	1.161	0.026	0.018
08 – Falconbridge, Lockerby	MW 0100	154	149	0.023	0.023	0.03	1.316	1.028	0.03	0.023
09 – Falconbridge, Metallurgical	PR 0100	157	75	0.006	0.005	0.028	5.124	1.954	0.031	0.012
10 – INCO, Refinery, Sudbury	SR 0100	157	55	0.033	0.033	0.12	3.641	1.684	0.12	0.056
11 – INCO, Nolin Creek T.P.	SW 0100									
12 – Falconbridge, Onaping	MW 0100	154	151	0.023	0.023	0.03	1.316	1	0.03	0.023
13 – INCO, Refinery, Port Colborne	SR 0100	153	126	0.017	0.017	0.043	2.557	1.354	0.043	0.023
14 – INCO, Shebandowan Mine	PR 0100	154	140	0.016	0.016	0.052	3.248	1.375	0.052	0.022
15 – Falconbridge, Strathcona	PR 0100	156	153	0.023	0.023	0.03	1.316	1.001	0.03	0.023
16 – INCO, Whistle Mine	MW 0100	89	63	0.018	0.018	0.046	2.507	1.361	0.046	0.025
17 – Minnova, Winston Lake Mine	PR 0100	94	85	0.018	0.018	0.03	1.64	1.143	0.029	0.021
19 – Dickenson, Arthur W. White Mine	PR 0100	136	100	0.032	0.032	0.126	3.953	1.397	0.126	0.045
21 – Canamax, Bell Creek Mine	PR 0100	42	5	7.167	7.384	33.164	4.491	1.877	32.187	13.455
24 – Teck – Corona, David Bell Mine	PR 0100	103	5	0.043	0.042	0.102	2.407	1.397	0.104	0.06
25 – Placer Dome, Detour Lake Mine	PR 0100									
26 – Placer Dome, Dome Mine	PR 0100	78	72	0.031	0.031	0.09	2.901	1.278	0.09	0.04
27 – Placer Dome, Dona Lake Mine	PR 0100	5	0	0.009	0.009	0.012	1.412	1.425	0.012	0.012
28 – Eastmaque Gold Mines	PR 0100									
29 – Giant Yellowknife, ERG Res.	PR 0100									
30 – Hemlo Gold Mines, Golden Giant	PR 0100	55	39	0.02	0.02	0.042	2.047	1.265	0.042	0.026
31 – Canamax, Kremzar Mine	PR 0100									
32 – LAC Minerals, Macassa Division	PR 0100	158	146	0.025	0.025	0.061	2.444	1.265	0.061	0.031
35 – Canamax, Marhill Mine	MW 0100	12	5	0.028	0.028	0.061	2.181	1.362	0.061	0.038
36 – American Barrick, McDermott	PR 0100	22	0	0.013	0.013	0.028	2.048	1.302	0.027	0.017
37 – Bond Gold, Muskegsagagagen Lake	PR 0100									
38 – LAC Minerals, Williams Mine	MW 0100									
38 – LAC Minerals, Williams Mine	PR 0200	55	5	0.029	0.029	0.059	2.025	1.299	0.059	0.038
39 – Giant Yellowknife, Pamour #1	PR 0100									
39 – Giant Yellowknife, Pamour #1	PR 0200									
40 – Giant Yellowknife, P–S	MW 0100									
42 – Renabie Gold Mines	PR 0100	8	2	0.008	0.008	0.03	3.618	1.691	0.028	0.013
45 – St. Andrews Gold Fields	PR 0100									
46 – Algoma Steel, Ore Division	PR 0100									
51 – Denison Mines, Denison Property	PR 0100									
51 – Denison Mines, Denison Property	SW 0200									
52 – Rio Algom, Lacnor/Nordic	SW 0100	12	1	0.038	0.039	0.082	2.104	1.31	0.081	0.05
53 – Rio Algom, Panel	SR 0100	12	2	0.044	0.044	0.138	3.098	1.533	0.136	0.067
54 – Rio Algom, Pronto	SW 0100									
55 – Rio Algom, Quirke	PR 0100	12	2	0.045	0.045	0.078	1.743	1.297	0.078	0.058
56 – Cameco, Refinery, Blind River	SR 0300	97	0	34.278	34.556	126.915	3.673	1.676	125.897	57.445
57 – Cameco, Refinery, Port Hope	SR 0100									
57 – Cameco, Refinery, Port Hope	SR 0200									
57 – Cameco, Refinery, Port Hope	SR 0300									
58 – Rio Algom, Stanleigh	SR 0100	11	1	0.057	0.058	0.196	3.364	1.606	0.192	0.092
59 – Denison Mines, Stanrock	SW 0100									

Site Performance Data: Zinc
MISA Metal Mining Sector

12 – Month Monitoring Data
February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156	108	0.01	0.01	0.141	14.785	2.653	0.141	0.025
02 – INCO, Crean Hill Mine	MW 0100	157	121	0.39	0.39	0.501	1.287	1.287	0.501	0.501
03 – Falconbridge, Falconbridge	PR 0100	156	99	0.019	0.016	0.143	8.695	2.716	0.162	0.051
04 – INCO, Garson Mine	MW 0100	157	107	0.009	0.009	0.037	3.98	1.708	0.037	0.016
05 – Noranda Minerals, Geco Division	PR 0100	138	1	0.06	0.06	0.201	3.382	1.615	0.204	0.097
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	1	1.23	1.265	10.536	8.328	2.726	10.245	3.353
07 – INCO, Levack Mine	MW 0100	148	116	0.009	0.009	0.051	5.665	2.05	0.051	0.018
08 – Falconbridge, Lockerby	MW 0100	154	92	0.017	0.017	0.127	7.633	2.497	0.131	0.043
09 – Falconbridge, Metallurgical	PR 0100	157	0	0.822	0.673	5.388	8.001	2.65	6.576	2.178
10 – INCO, Refinery, Sudbury	SR 0100	156	77	0.009	0.009	0.03	3.207	1.548	0.03	0.015
11 – INCO, Nolin Creek T.P.	SW 0100	12	2	0.062	0.071	0.605	8.586	2.756	0.53	0.17
12 – Falconbridge, Onaping	MW 0100	154	103	0.033	0.023	0.281	12.153	3.423	0.407	0.115
13 – INCO, Refinery, Port Colborne	SR 0100	153	83	0.009	0.009	0.03	3.35	1.573	0.031	0.015
14 – INCO, Shebandowan Mine	PR 0100	154	142	0.007	0.007	0.035	5.014	1.93	0.036	0.014
15 – Falconbridge, Strathcona	PR 0100	156	93	0.028	0.02	0.185	9.118	2.806	0.253	0.078
16 – INCO, Whistle Mine	MW 0100	89	14	0.074	0.073	0.509	6.998	2.409	0.518	0.178
17 – Minnova, Winston Lake Mine	PR 0100	100	0	0.426	0.42	1.481	3.525	1.643	1.503	0.701
19 – Dickenson, Arthur W. White Mine	PR 0100	136	0	0.122	0.121	0.255	2.114	1.319	0.257	0.16
21 – Canamax, Bell Creek Mine	PR 0100	3	0	0.467	0.507	2.16	4.259	1.804	1.988	0.842
24 – David Bell Mine	PR 0100	110	75	0.008	0.008	0.021	2.578	1.374	0.021	0.011
25 – Placer Dome, Detour Lake Mine	PR 0100	157	121	0.012	0.012	0.057	4.794	1.583	0.057	0.019
26 – Placer Dome, Dome Mine	PR 0100	78	55	0.019	0.019	0.144	7.564	2.478	0.146	0.048
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmaque Gold Mines	PR 0100	156	137	0.011	0.011	0.031	2.788	1.4	0.031	0.015
29 – Giant Yellowknife, ERG Res.	PR 0100									
30 – Hemlo Gold Mines, Golden Giant	PR 0100	61	15	0.021	0.02	0.084	4.31	1.833	0.09	0.038
31 – Canamax, Kremzar Mine	PR 0100									
32 – LAC Minerals, Macassa Division	PR 0100	158	92	0.015	0.015	0.056	3.739	1.642	0.056	0.025
35 – Canamax, Marhill Mine	MW 0100	12	1	0.026	0.027	0.089	3.291	1.6	0.087	0.042
36 – American Barrick, McDermott	PR 0100	22	0	0.018	0.019	0.053	2.888	1.501	0.053	0.027
37 – Bond Gold, Muskegsagagagen Lake	PR 0100									
38 – LAC Minerals, Williams Mine	MW 0100	24	14	0.011	0.011	0.036	3.255	1.572	0.036	0.018
38 – LAC Minerals, Williams Mine	PR 0200	65	28	0.009	0.009	0.024	2.538	1.373	0.024	0.013
39 – Giant Yellowknife, Pamour #1	PR 0100	116	69	0.071	0.079	0.988	12.451	3.435	0.881	0.243
39 – Giant Yellowknife, Pamour #1	PR 0200	22	18	0.011	0.011	0.028	2.513	1.34	0.028	0.015
40 – Giant Yellowknife, P–S	MW 0100	16	0	0.091	0.09	0.519	5.781	2.139	0.529	0.196
42 – Renabie Gold Mines	PR 0100	8	0	1.671	1.733	6.936	4.004	1.748	6.691	2.922
45 – St. Andrews Gold Fields	PR 0100	5	2	0.01	0.011	0.035	3.292	1.622	0.034	0.017
46 – Algoma Steel, Ore Division	PR 0100	6	3	0.01	0.01	0.059	5.641	2.073	0.054	0.02
51 – Denison Mines, Denison Property	PR 0100	12	1	0.039	0.04	0.207	5.241	2.03	0.203	0.078
51 – Denison Mines, Denison Property	SW 0200									
52 – Rio Algom, Lacnor/Nordic	SW 0100	12	4	0.014	0.014	0.064	4.439	1.924	0.064	0.028
53 – Rio Algom, Panel	SR 0100	12	0	0.049	0.05	0.26	5.258	2.023	0.257	0.099
54 – Rio Algom, Pronto	SW 0100	6	3	0.01	0.01	0.011	1.082	1.037	0.011	0.011
55 – Rio Algom, Quirke	PR 0100	12	0	0.04	0.041	0.16	3.924	1.731	0.156	0.069
56 – Cameco, Refinery, Blind River	SR 0300	9	0	0.028	0.03	0.146	4.882	1.94	0.137	0.054
57 – Cameco, Refinery, Port Hope	SR 0100	9	1	0.012	0.013	0.045	3.58	1.67	0.045	0.021
57 – Cameco, Refinery, Port Hope	SR 0200	9	1	0.01	0.01	0.033	3.226	1.588	0.032	0.016
57 – Cameco, Refinery, Port Hope	SR 0300	9	0	0.02	0.02	0.094	4.719	1.905	0.095	0.039
58 – Rio Algom, Stanleigh	SR 0100	11	0	0.031	0.031	0.07	2.285	1.46	0.07	0.045
59 – Denison Mines, Stanrock	SW 0100	12	6	0.013	0.014	0.068	4.899	1.891	0.066	0.025

Site Performance Data: Arsenic — 12 – Month Monitoring Data
MISA Metal Mining Sector — February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156	129	0.1	0.1	1.4	13.964	1.203	1.4	0.121
02 – INCO, Crean Hill Mine	MW 0100	157	151	0.001	0.001	0.002	1.476	1.102	0.002	0.002
03 – Falconbridge, Falconbridge	PR 0100	156	99	0.005	0.005	0.028	5.682	2.056	0.029	0.011
04 – INCO, Garson Mine	MW 0100	157	146	0.002	0.002	0.01	6.562	2.023	0.01	0.003
05 – Noranda Minerals, Geco Division	PR 0100	141	135	0.004	0.004	0.005	1.396	1.011	0.005	0.004
06 – Falconbridge, Kidd Creek Mine	MW 0100	148	111	0.002	0.002	0.006	2.753	1.397	0.006	0.003
07 – INCO, Levack Mine	MW 0100	148	140	0.006	0.006	0.006	1.023	1.023	0.006	0.006
08 – Falconbridge, Lockerby	MW 0100	155	147	0.003	0.003	0.005	2.058	1.259	0.005	0.003
09 – Falconbridge, Metallurgical	PR 0100	157	88	0.017	0.013	0.176	13.512	3.671	0.224	0.061
10 – INCO, Refinery, Sudbury	SR 0100	157	19	0.007	0.007	0.033	4.954	1.966	0.035	0.014
11 – INCO, Nolin Creek T.P.	SW 0100									
12 – Falconbridge, Onaping	MW 0100	155	149	0.003	0.003	0.007	2.484	1.34	0.007	0.004
13 – INCO, Refinery, Port Colborne	SR 0100	152	0	0.107	0.115	0.542	4.72	1.905	0.507	0.205
14 – INCO, Shebandowan Mine	PR 0100	154	151	0.001	0.001	0.002	1.498	1.076	0.002	0.002
15 – Falconbridge, Strathcona	PR 0100	156	145	0.003	0.003	0.005	1.819	1.183	0.005	0.003
16 – INCO, Whistle Mine	MW 0100									
17 – Minnova, Winston Lake Mine	PR 0100	100	64	0.002	0.002	0.005	2.347	1.19	0.005	0.003
19 – Dickenson, Arthur W. White Mine	PR 0100	136	0	1.101	1.099	1.834	1.668	1.204	1.838	1.326
21 – Canamax, Bell Creek Mine	PR 0100	3	0	0.41	0.416	0.774	1.862	1.255	0.763	0.515
24 – Teck – Corona, David Bell Mine	PR 0100	109	93	0.003	0.003	0.009	2.784	1.352	0.009	0.004
25 – Placer Dome, Detour Lake Mine	PR 0100									
26 – Placer Dome, Dome Mine	PR 0100	78	40	0.006	0.006	0.011	1.957	1.242	0.011	0.007
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmaque Gold Mines	PR 0100	156	151	0.005	0.005	0.01	1.997	1.214	0.01	0.006
29 – Giant Yellowknife, ERG Res.	PR 0100									
30 – Hemlo Gold Mines, Golden Giant	PR 0100	69	28	0.004	0.003	0.011	3.215	1.515	0.011	0.005
31 – Canamax, Kremzar Mine	PR 0100	5	2	0.002	0.003	0.017	6.24	2.219	0.015	0.005
32 – LAC Minerals, Macassa Division	PR 0100									
35 – Canamax, Marhill Mine	MW 0100	8	1	0.118	0.118	0.232	1.96	1.411	0.232	0.167
36 – American Barrick, McDermott	PR 0100									
37 – Bond Gold, Muskegsagagagen Lake	PR 0100									
38 – LAC Minerals, Williams Mine	MW 0100	24	0	0.047	0.047	0.138	2.914	1.507	0.136	0.07
38 – LAC Minerals, Williams Mine	PR 0200	65	61	0.003	0.003	0.003	1.017	1.017	0.003	0.003
39 – Giant Yellowknife, Pamour #1	PR 0100	116	22	0.019	0.018	0.082	4.659	1.904	0.089	0.036
39 – Giant Yellowknife, Pamour #1	PR 0200	22	0	0.009	0.009	0.016	1.743	1.224	0.016	0.011
40 – Giant Yellowknife, P – S	MW 0100									
42 – Renabie Gold Mines	PR 0100	8	3	0.002	0.002	0.01	5.954	2.138	0.009	0.003
45 – St. Andrews Gold Fields	PR 0100	5	0	0.009	0.009	0.034	3.57	1.653	0.033	0.015
46 – Algoma Steel, Ore Division	PR 0100	6	0	0.001	0.001	0.003	2.469	1.404	0.003	0.002
51 – Denison Mines, Denison Property	PR 0100	12	2	0.026	0.026	0.043	1.638	1.35	0.043	0.035
51 – Denison Mines, Denison Property	SW 0200									
52 – Rio Algom, Lacnor/Nordic	SW 0100									
53 – Rio Algom, Panel	SR 0100									
54 – Rio Algom, Pronto	SW 0100									
55 – Rio Algom, Quirke	PR 0100									
56 – Cameco, Refinery, Blind River	SR 0300									
57 – Cameco, Refinery, Port Hope	SR 0100									
57 – Cameco, Refinery, Port Hope	SR 0200	9	6	0.009	0.01	0.053	5.526	2.057	0.05	0.019
57 – Cameco, Refinery, Port Hope	SR 0300									
58 – Rio Algom, Stanleigh	SR 0100									
59 – Denison Mines, Stanrock	SW 0100									

Site Performance Data: Cyanide (Total)	12 – Month Monitoring Data
MISA Metal Mining Sector	February 1, 1990 to January 31 1991

Company	Ctrlpt.	N	NLDL	LTA	EX	P99	VF1	VF4	DAYLIM	M4LIM
01 – INCO, Copper Cliff T.P.	PR 0100	156	45	0.016	0.016	0.067	4.209	1.822	0.068	0.029
02 – INCO, Crean Hill Mine	MW 0100									
03 – Falconbridge, Falconbridge	PR 0100	95	22	0.008	0.008	0.02	2.491	1.408	0.02	0.011
04 – INCO, Garson Mine	MW 0100									
05 – Noranda Minerals, Geco Division	PR 0100	142	107	0.016	0.017	0.253	14.96	3.838	0.246	0.063
06 – Falconbridge, Kidd Creek Mine	MW 0100									
07 – INCO, Levack Mine	MW 0100									
08 – Falconbridge, Lockerby	MW 0100	94	41	0.007	0.007	0.013	2.04	1.286	0.013	0.008
09 – Falconbridge, Metallurgical	PR 0100	156	0	1.294	1.294	7.126	5.506	1.723	7.126	2.231
10 – INCO, Refinery, Sudbury	SR 0100									
11 – INCO, Nolin Creek T.P.	SW 0100									
12 – Falconbridge, Onaping	MW 0100	95	9	0.009	0.009	0.02	2.152	1.339	0.02	0.012
13 – INCO, Refinery, Port Colborne	SR 0100									
14 – INCO, Shebandowan Mine	PR 0100									
15 – Falconbridge, Strathcona	PR 0100	156	93	0.006	0.006	0.011	1.985	1.24	0.011	0.007
16 – INCO, Whistle Mine	MW 0100									
17 – Minnova, Winston Lake Mine	PR 0100									
19 – Dickenson, Arthur W. White Mine	PR 0100	136	2	0.181	0.197	1.212	6.141	2.221	1.109	0.401
21 – Canamax, Bell Creek Mine	PR 0100									
24 – Teck – Corona, David Bell Mine	PR 0100									
25 – Placer Dome, Detour Lake Mine	PR 0100									
26 – Placer Dome, Dome Mine	PR 0100									
27 – Placer Dome, Dona Lake Mine	PR 0100									
28 – Eastmaque Gold Mines	PR 0100	156	17	0.147	0.2	2.265	11.334	3.385	1.666	0.497
29 – Giant Yellowknife, ERG Res.	PR 0100	18	0	0.22	0.255	2.978	11.663	3.5	2.567	0.77
30 – Hemlo Gold Mines, Golden Giant	PR 0100	20	0	0.126	0.128	0.511	3.99	1.745	0.504	0.22
31 – Canamax, Kremzar Mine	PR 0100	47	0	0.035	0.036	0.15	4.139	1.778	0.143	0.061
32 – LAC Minerals, Macassa Division	PR 0100	158	11	0.942	0.702	8.848	12.597	3.655	11.861	3.441
35 – Canamax, Marhill Mine	MW 0100									
36 – American Barrick, McDermott	PR 0100	22	0	0.01	0.01	0.016	1.609	1.188	0.016	0.012
37 – Bond Gold, Muskegsagagagen Lake	PR 0100	134	0	0.041	0.042	0.111	2.669	1.451	0.111	0.06
38 – LAC Minerals, Williams Mine	MW 0100									
38 – LAC Minerals, Williams Mine	PR 0200	47	0	0.117	0.113	0.442	3.893	1.724	0.457	0.202
39 – Giant Yellowknife, Pamour #1	PR 0100	116	23	0.663	0.281	4.117	14.628	3.868	9.696	2.564
39 – Giant Yellowknife, Pamour #1	PR 0200	22	1	0.229	0.297	3.093	10.402	3.202	2.382	0.733
40 – Giant Yellowknife, P – S	MW 0100	16	12	0.028	0.039	0.646	16.649	3.893	0.464	0.109
42 – Renabie Gold Mines	PR 0100	84	0	2.873	3.385	41.822	12.355	3.639	35.496	10.455
45 – St. Andrews Gold Fields	PR 0100	61	0	0.113	0.124	0.895	7.243	2.472	0.816	0.278
46 – Algoma Steel, Ore Division	PR 0100									
51 – Denison Mines, Denison Property	PR 0100									
51 – Denison Mines, Denison Property	SW 0200									
52 – Rio Algom, Lacnor/Nordic	SW 0100									
53 – Rio Algom, Panel	SR 0100	4	1	0.001	0.001	0.003	2	1.571	0.003	0.002
54 – Rio Algom, Pronto	SW 0100									
55 – Rio Algom, Quirke	PR 0100	4	0	0.026	0.026	0.084	3.213	1.783	0.084	0.046
56 – Cameco, Refinery, Blind River	SR 0300	4	0	0.95	0.982	2.998	3.054	1.539	2.901	1.462
57 – Cameco, Refinery, Port Hope	SR 0100									
57 – Cameco, Refinery, Port Hope	SR 0200									
57 – Cameco, Refinery, Port Hope	SR 0300									
58 – Rio Algom, Stanleigh	SR 0100									
59 – Denison Mines, Stanrock	SW 0100									

Annual Loadings

Estimated Loading Reductions

Appendix 13

of the

Development Document

Total Suspended Solids

Present Annual Loadings and Estimated Reductions (kg/year)
for MISA Metal Mining Sector

Present Annual Loadings kg/year	2161627
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 15.0 mg/L	1660888
Reduction in Loading kg/year	500739
% Reduction	23.2

Copper

Present Annual Loadings and Estimated Reductions (kg/year)
for MISA Metal Mining Sector

Present Annual Loadings kg/year	37949
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.3 mg/L	24191
Reduction in Loading kg/year	13758
% Reduction	36.3
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.1 mg/L	11274
Reduction in Loading kg/year	26675
% Reduction	70.3

Nickel

Present Annual Loadings and Estimated Reductions (kg/year)
for MISA Metal Mining Sector

Present Annual Loadings kg/year	60747
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.5 mg/L	39311
Reduction in Loading kg/year	21436
% Reduction	35.3
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.1 mg/L	12427
Reduction in Loading kg/year	48320
% Reduction	79.5

Lead

Present Annual Loadings and Estimated Reductions (kg/year) for MISA Metal Mining Sector

Present Annual Loadings kg/year	4240
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.2 mg/L	4240
Reduction in Loading kg/year	0
% Reduction	0.0
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.1 mg/L	4206
Reduction in Loading kg/year	33
% Reduction	0.8

Zinc

Present Annual Loadings and Estimated Reductions (kg/year) for MISA Metal Mining Sector

Present Annual Loadings kg/year	32238
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.5 mg/L	16292
Reduction in Loading kg/year	15946
% Reduction	49.5
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.1 mg/L	6754
Reduction in Loading kg/year	25484
% Reduction	79.1

Arsenic

Present Annual Loadings and Estimated Reductions (kg/year) for MISA Metal Mining Sector

Present Annual Loadings kg/year	13098
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 0.5 mg/L	7381
Reduction in Loading kg/year	5717
% Reduction	43.7

Cyanide

Present Annual Loadings and Estimated Reductions (kg/year) for MISA Metal Mining Sector

Present Annual Loadings kg/year	51974
Loadings (kg/year) Expected with a Monthly Average Concentration Not Exceeding 1.0 mg/L	30961
Reduction in Loading kg/year	21014
% Reduction	40.4

Total suspended solids

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
01 – INCO, Copper Cliff T.P. PR 0100	Days of Discharge	28	31	30	31	30	30	31	30	31	30	31	31	364
	Present Monthly Loadings, kg	48879.23	70138.31	58907.87	75602.83	72958.25	11704.26	17411.61	22078.14	61126.01	100673.2	72314.28	83491.88	681286.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	45387	55370.77	49101.92	57733.07	48105	11704.26	17411.61	22078.14	58524.9	42702	51045.38	40399.2	499544.6
	Reduction in Loadings	1512.233	14765.54	7805.947	17869.76	24854.25	0	0	0	2601.107	57971.2	21268.91	43092.68	191741.4
	% Reduction	3.23	21.05	13.72	23.64	34.07	0.00	0.00	0.00	4.26	57.58	29.41	51.61	27.7
02 – INCO, Crean Hill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	201.61	808.18	393.03	338.46	215.79	185.09	53.03	107.24	224.18	490.77	290.7	169.78	3475.9
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	201.61	808.18	393.03	338.46	215.79	185.09	53.03	107.24	224.18	490.77	290.7	169.78	3475.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
03 – Falconbridge, Falconbridge PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	3560.32	5852.98	5857.17	2942.82	1354.12	1312.07	1772.85	1418.6	1316.02	1692.32	1109.27	1198.58	29188.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	3560.32	5852.98	5857.17	2942.82	1354.12	1312.07	1772.85	1418.6	1316.02	1692.32	1109.27	1198.58	29188.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
04 – INCO, Garson Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	458.33	1399.3	859.05	939.98	484.53	354.02	279.36	430.65	1106.77	973.7	1160.55	759.32	9184.5
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	458.33	1399.3	859.05	939.98	484.53	354.02	279.36	430.65	1106.77	973.7	1160.55	759.32	9184.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
05 – Noranda Minerals, Geco Division PR 0100	Days of Discharge	28.00	21.15	29.25	30.29	29.90	29.87	20.19	28.04	30.57	29.17	29.99	30.04	336.46
	Present Monthly Loadings, kg	737.85	538.11	1034.37	1724.34	5309.85	5457.88	2047.48	5557.05	2498.98	2378.38	2171.58	1554.55	31006.3
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	737.85	538.11	1034.37	1724.34	2478.09	2834.38	2047.48	2473.48	2498.98	2378.38	2171.58	1554.55	22285.5
	Reduction in Loadings	0	0	0	0	2833.752	2623.495	0	3083.588	0	0	0	0	8740.8
	% Reduction	0	0	0	0	53.37	51.73	0	55.48	0	0	0	0	28.2
06 – Falconbridge, Kidd Creek Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	635.02	5394.08	6744.42	2199.18	4479.85	3386.4	808.72	2190.9	8292.72	5338.87	5974.96	2005.41	47460.3
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	635.02	5394.08	6744.42	2199.18	4479.85	3386.4	808.72	2190.9	8292.72	5338.87	4655.81	2005.41	46141.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	1319.147	0	1319.1
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.08	0.00	2.8
07 – INCO, Levack Mine MW 0100	Days of Discharge	28.00	30.00	30.00	31.00	30.00	31.00	31.00	30.00	29.00	15.00	31.00	31.00	347
	Present Monthly Loadings, kg	1709.27	1717.84	555.21	290.71	387.44	815.84	96.13	211.92	261.68	5088.12	3588.79	2857.21	17358.3
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1094.91	1498.52	555.21	290.71	387.44	815.84	96.13	211.92	261.68	1674.77	1132.31	1025.51	9048.3
	Reduction in Loadings	614.3835	219.1324	0	0	0	0	0	0	0	3413.344	2434.474	1831.702	8312.0
	% Reduction	35.94	12.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.08	88.25	61.41	47.9
08 – Falconbridge, Lockerby MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	78.79	231.87	215.43	130.32	48.3	51.02	43.31	74.42	58.54	92.09	63.08	51.46	1138.4
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	78.78	231.87	215.43	130.32	48.3	51.02	43.31	74.42	58.54	92.08	63.08	51.46	1138.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
09 – Falconbridge, Metallurgical PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	25771.73	47928.88	43870.15	8032.32	8620.85	8138.01	4443.63	6100.78	11485.91	13629.21	23738.54	28040.95	227300.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	15055.38	43859.92	40050	8032.32	8620.85	8138.01	4443.63	6100.78	11485.91	13629.21	18300.04	18983.23	191697.3
	Reduction in Loadings	10718.35	4298.97	3820.154	0	0	0	0	0	0	0	7438.505	9057.723	35302.7
	% Reduction	41.58	8.81	8.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.34	34.78	15.5

Total suspended solids

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Year
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	631.51	469.28	408.55	404.99	485	120.07	385.21	369.54	564.01	674.43	492.6	420.58	5425.8
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	631.51	469.28	408.55	404.99	485	120.07	385.21	369.54	564.01	674.43	492.6	420.58	5425.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	1436.4	7142.4	8415	20712.96	11880	26784	6361.2	2304	33858.56	6318	42705.6	892.8	168810.6
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1436.4	7142.4	8415	6472.8	8100	10044	5301	2304	5803.2	6318	7812	892.8	70041.6
	Reduction in Loadings	0	0	0	14240.16	3780	16740	1060.2	0	27855.36	0	34893.6	0	98569.3
	% Reduction	0.00	0.00	0.00	68.75	31.82	62.50	16.67	0.00	82.76	0.00	81.71	0.00	58.5
12 – Falconbridge, Onaping MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	280.8	334.05	322.33	227.31	187.79	148.85	265.18	203.74	248.22	569.92	258.21	435.4	3477.8
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	280.8	334.05	322.33	227.31	187.78	148.85	265.18	203.74	248.22	569.92	258.21	435.4	3477.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13 – INCO, Refinery, Port Colborne SR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	1046.95	3923.9	4598.88	2576.83	1961.37	807.35	885.86	2203.27	1787.16	2083.48	3009.06	2885.22	27547.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1046.95	3923.9	4598.88	2576.83	1961.37	807.35	885.86	2203.27	1787.16	2083.48	3009.06	2865.22	27547.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14 – INCO, Shebandowen Mine PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	258.77	518.47	578.74	1754.14	1176.81	481.31	202.75	341.82	898.27	618.85	584.41	524.96	7721.4
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	258.77	518.47	578.74	1754.14	1176.81	481.31	202.75	341.82	898.27	618.85	584.41	524.96	7721.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15 – Falconbridge, Strathcona PR 0100	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	16.00	23.00	31.00	260
	Present Monthly Loadings, kg	3812.23	4905.48	25072.69	5368.55	995.52	948.29	1669.93	0.00	0.00	1453.24	360.30	618.84	45201.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	3812.23	4905.48	25072.69	5368.55	995.52	948.29	1669.93	0	0	1453.24	360.3	618.84	45201.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16 – INCO, Whistle Mine MW 0100	Days of Discharge	0.00	11.00	16.00	31.00	30.00	29.00	0.00	0.00	22.00	30.00	31.00	14.00	214
	Present Monthly Loadings, kg	0	75.25	55.36	218.45	87.34	79.59	0	0	139.61	185.55	206.58	10.1	1057.8
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	75.25	39.78	190.35	87.34	79.59	0	0	139.61	185.55	206.58	10.1	1014.2
	Reduction in Loadings	0	0	15.5805	28.0994	0	0	0	0	0	0	0	0	43.7
	% Reduction	0.00	0.00	28.14	12.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.1
17 – Minnova, Winston Lake Mine PR 0100	Days of Discharge	0.00	0.00	0.00	31.00	30.00	31.00	31.00	15.00	27.00	15.00	31.00	31.00	242
	Present Monthly Loadings, kg	0	0	0	355.39	1088.2	1260.87	521.05	127.58	1853.04	255.45	183.87	237.33	5660.7
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	355.39	1015.43	887.66	521.05	127.58	1052.65	255.45	183.87	237.33	4636.2
	Reduction in Loadings	0	0	0	0	50.7713	373.2829	0	0	800.3978	0	0	0	1024.5
	% Reduction	0.00	0.00	0.00	0.00	4.78	29.60	0.00	0.00	36.32	0.00	0.00	0.00	18.1
19 – Dickenson, Arthur W. White Mine PR 0100	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	318
	Present Monthly Loadings, kg	1449.01	2358.52	1429.80	0.00	14513.14	12480.80	11867.69	11811.31	13350.03	3960.02	2050.06	1729.30	76796.7
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1449.01	2358.52	1429.8	0	14513.14	12480.8	11867.69	11811.31	13350.03	3960.02	2050.06	1729.3	76796.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Total suspended solids

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												*Total Year*
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
21 – Canamax, Bell Creek Mine	Days of Discharge	0	0	0	0	0	4	31	23	31	6	0	0	95
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	166.96	273.1	38.72	279.19	152.09	0	0	932.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	0	0	139.4	273.1	38.72	279.19	152.09	0	0	882.5
	Reduction in Loadings	0	0	0	0	0	48.5844	0	0	0	0	0	0	49.6
	% Reduction	0.00	0.00	0.00	0.00	0.00	28.23	0.00	0.00	0.00	0.00	0.00	0.00	5.3
24 – Teck – Corona, David Bell Mine	Days of Discharge	25.00	8.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	284
PR 0100	Present Monthly Loadings, kg	49.41	7.23	0	55.19	53.63	56.82	48.07	121.72	27.91	100.13	71.28	83.99	676.4
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	49.41	7.23	0	55.19	53.63	56.82	48.07	121.72	27.91	100.13	71.28	83.99	676.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25 – Placer Dome, Detour Lake Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	829.8	1109.92	3193.5	26811.9	9523.66	4276.41	8.53	42.92	14219.18	7075.18	2269.08	1252.18	70612.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	829.8	1109.92	3193.5	26811.9	9523.66	4276.41	8.53	42.92	14219.18	7075.18	2269.08	1252.18	70612.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
26 – Placer Dome, Dome Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	5.00	23.00	331
PR 0100	Present Monthly Loadings, kg	1871.4	3503.45	8047.09	7910.77	4762.37	6220.28	4874.52	2512.31	3748.92	3158.4	430.24	1811.13	48446.9
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1871.4	3503.45	8047.09	7910.77	4762.37	6220.28	4874.52	2512.31	3748.92	3158.4	430.24	1811.13	48446.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27 – Placer Dome, Done Lake Mine	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
PR 0100	Present Monthly Loadings, kg	0	0	0	1537.29	2974.64	2011.16	0	0	1109.43	559.42	0	0	8191.9
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	1537.29	2974.64	2011.16	0	0	1109.43	559.42	0	0	8191.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28 – Eastmaque Gold Mines	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	249.42	3457.45	27008.54	11137.09	1270.68	1312.85	550.51	1155.33	4960.55	2961.14	978.75	430.58	55472.9
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	249.42	3457.45	10408.43	9401.44	1270.68	1312.85	550.51	1155.33	4960.55	2961.14	978.75	430.58	37137.1
	Reduction in Loadings	0	0	16600.11	1735.651	0	0	0	0	0	0	0	0	18335.8
	% Reduction	0.00	0.00	61.48	15.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.1
29 – Giant Yellowknife, ERG Res.	Days of Discharge	0.00	0.00	27.00	4.00	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	44
PR 0100	Present Monthly Loadings, kg	0	0	9442.29	1038.8	0	0	0	0	7789.84	0	0	0	18248.9
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	9442.29	1038.8	0	0	0	0	7789.84	0	0	0	18248.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30 – Hemlo Gold Mines, Golden Giant	Days of Discharge	0.00	0.00	0.00	0.00	0.00	18.00	31.00	30.00	31.00	30.00	31.00	19.00	188
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	1271.46	2215.7	4243.37	1280.1	1137.13	800.38	709.53	11857.7
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	0	0	1271.46	2215.7	2168.83	1280.1	1137.13	800.38	709.53	9581.2
	Reduction in Loadings	0	0	0	0	0	0	0	2078.541	0	0	0	0	2078.5
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.94	0.00	0.00	0.00	0.00	17.6
31 – Canamax, Kremzar Mine	Days of Discharge	0.00	0.00	18.00	18.00	0.00	8.00	0.00	18.00	0.00	0.00	0.00	0.00	59
PR 0100	Present Monthly Loadings, kg	0.00	0.00	1446.39	554.50	0.00	223.77	0.00	575.28	0.00	0.00	0.00	0.00	2799.9
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	1446.39	554.5	0	223.77	0	575.28	0	0	0	0	2799.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Total suspended solids

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
32 – LAC Minerals, Macassa Division	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
PR 0100	Present Monthly Loadings, kg	411.81	1368.1	2282.18	59122.32	1323.87	2128.08	1135.96	519.44	2850.73	3375.58	2038.46	414.44	76990.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	411.81	1368.1	2282.18	59122.32	1323.87	2128.08	1135.96	519.44	2504.82	3375.58	2038.46	414.44	76644.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	345.904	0	0	0	345.9
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.13	0.00	0.00	0.00	0.4
35 – Canamax, Merhill Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
MW 0100	Present Monthly Loadings, kg	10537.4	11358.42	10804.35	11503.83	7168.84	1440.42	2980.45	1698.32	2445.38	4699.14	3218.29	3107.53	70958.3
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	500.32	530.39	641.35	845.53	742.98	603.77	596.7	518.4	533.26	512.2	505.55	500.77	6831.2
	Reduction in Loadings	10037.08	10828.03	10162.99	10658.1	6423.86	836.652	2383.75	1177.92	1912.102	4186.938	2710.735	2606.767	64125.0
	% Reduction	95.25	95.33	94.06	94.38	89.63	58.08	79.98	69.44	78.19	89.10	84.28	83.89	90.4
36 – American Barrick, McDermott	Days of Discharge	0.00	11.00	27.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
PR 0100	Present Monthly Loadings, kg	0	1065.7	1706.85	1812.82	0	0	0	0	0	0	0	0	4585.5
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	1065.7	1706.85	1812.82	0	0	0	0	0	0	0	0	4585.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
37 – Bond Gold, Muskegsagegen Lake	Days of Discharge	28.00	3.00	10.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	317
PR 0100	Present Monthly Loadings, kg	41.52	3.84	682.74	427.83	597.83	121.81	167.05	73.02	438.46	251.8	28.9	8.3	2844.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	41.52	3.84	682.74	427.83	597.83	121.81	167.05	73.02	438.46	251.8	28.9	8.3	2844.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
38 – LAC Minerals, Williams Mine	Days of Discharge	28.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56
MW 0100	Present Monthly Loadings, kg	647.58	822.53	0	0	0	0	0	0	0	0	0	0	1470.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	633.5	691.84	0	0	0	0	0	0	0	0	0	0	1325.3
	Reduction in Loadings	14.0778	130.6818	0	0	0	0	0	0	0	0	0	0	144.8
	% Reduction	2.17	15.88	0	0	0	0	0	0	0	0	0	0	9.8
38 – LAC Minerals, Williams Mine	Days of Discharge	0.00	0.00	0.00	10.00	28.00	31.00	31.00	30.00	17.00	0.00	0.00	0.00	146
PR 0200	Present Monthly Loadings, kg	0.00	0.00	0.00	90.59	387.43	439.78	476.5	755.23	433.83	0.00	0.00	0.00	2583.4
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	90.58	387.43	439.78	476.5	755.23	433.83	0	0	0	2583.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
39 – Giant Yellowknife, Pamour #1	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	15.00	31.00	30.00	0.00	21.00	309
PR 0100	Present Monthly Loadings, kg	3407.96	1155.76	1374.11	8505.72	1296.81	3451.37	1833.2	158.44	838.76	430.83	0	157.65	22410.8
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1226.87	1155.76	1374.11	4483.64	1296.81	2045.84	1568.84	158.44	838.76	430.83	0	157.65	14717.4
	Reduction in Loadings	2181.096	0	0	4042.078	0	1405.724	64.3626	0	0	0	0	0	7693.3
	% Reduction	64.00	0.00	0.00	47.52	0.00	40.73	3.64	0.00	0.00	0.00	0.00	0.00	34.3
39 – Giant Yellowknife, Pamour #1	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
PR 0200	Present Monthly Loadings, kg	0	0	0	0	0	0	0	412.3	1788.18	50.18	0	0	2230.6
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	0	0	0	0	220	852.81	50.18	0	0	1123.0
	Reduction in Loadings	0	0	0	0	0	0	0	192.2964	815.3494	0	0	0	1107.6
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.64	51.77	0.00	0.00	0.00	49.7
42 – Renabie Gold Mines	Days of Discharge	0.00	14.00	30.00	28.00	28.00	30.00	1.00	5.00	0.00	18.00	0.00	0.00	152
PR 0100	Present Monthly Loadings, kg	0.00	2448.74	8511.87	1837.85	719.24	829.70	4.80	36.46	0.00	58.56	0.00	0.00	12247.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	2448.74	8511.87	1837.85	719.24	829.7	4.8	36.46	0	58.56	0	0	12247.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Total suspended solids

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
45 – St. Andrews Gold Fields	Days of Discharge	0	0	0	0	0	28	31	30	31	28	0	0	147
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	1896.01	606.12	285.03	845.32	482.32	0	0	4324.8
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	0	0	0	0	588.05	420.3	285.03	845.32	443.08	0	0	2581.8
	Reduction in Loadings	0	0	0	0	0	1307.964	385.8184	0	0	49.2315	0	0	1743.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	68.98	47.88	0.00	0.00	10.00	0.00	0.00	40.3
46 – Algoma Steel, Ore Division	Days of Discharge	28.00	31.00	30.00	31.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	180
PR 0100	Present Monthly Loadings, kg	3819.54	5922.98	2751.06	852.87	1022.99	966.58	0	0	0	0	0	0	15138.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	3819.54	5097.01	2751.06	852.87	1022.99	966.56	0	0	0	0	0	0	14310.1
	Reduction in Loadings	0	825.9787	0	0	0	0	0	0	0	0	0	0	828.0
	% Reduction	0.00	13.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.5
51 – Denison Mines, Denison Property	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	8781.54	10846.89	7244.23	11164.25	14437.18	5396.59	4143.17	5389.48	8171.24	4717.33	4310.79	4964.41	85577.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	8791.54	10846.89	7244.23	11164.25	14123.33	5396.59	4143.17	5389.48	8171.24	4717.33	4310.79	4964.41	85243.3
	Reduction in Loadings	0	0	0	0	313.8518	0	0	0	0	0	0	0	313.9
	% Reduction	0.00	0.00	0.00	0.00	2.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4
51 – Denison Mines, Denison Property	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	23.00	16.00	31.00	30.00	31.00	31.00	343
SW 0200	Present Monthly Loadings, kg	33.91	22.52	87.07	33.72	31.08	53.57	15.92	11.07	35.34	51.84	117.8	32.12	526.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	33.91	22.52	87.07	33.72	31.08	53.57	15.92	11.07	35.34	51.84	117.8	32.12	526.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
52 – Rio Algom, Lacnor/Nordic	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
SW 0100	Present Monthly Loadings, kg	75.49	3323.82	5048.06	178.93	21.51	348.77	3.21	8.82	188.19	1924.32	202.18	668.38	11968.5
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	75.48	3323.82	5048.06	178.93	21.51	348.77	3.21	8.82	188.19	1924.32	202.18	668.38	11968.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel	Days of Discharge	28.00	31.00	30.00	30.87	29.87	31.00	31.00	30.00	22.68	21.21	28.00	25.21	336.45
SR 0100	Present Monthly Loadings, kg	479.19	1388.75	2224.55	1255.08	970.80	606.27	536.19	624.60	580.48	473.91	825.87	757.26	10923.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	479.19	1388.75	2224.55	1255.08	970.9	606.27	536.19	624.6	580.48	473.91	825.87	757.26	10923.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
54 – Rio Algom, Pronto	Days of Discharge	0.00	12.00	29.87	31.00	28.25	0.00	11.00	0.00	0.00	0.00	21.00	0.00	132.92
SW 0100	Present Monthly Loadings, kg	0	390.72	459.39	83.02	56.87	0	159.87	0	0	0	1724.44	0	2874.1
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	0	390.72	459.39	83.02	56.87	0	159.87	0	0	0	1724.44	0	2874.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
55 – Rio Algom, Quirke	Days of Discharge	28.00	31.00	30.00	30.33	30.00	31.00	30.00	30.00	30.50	27.70	19.42	23.92	341.87
PR 0100	Present Monthly Loadings, kg	1488.4	4093.95	4000	458.38	2459.38	1079.15	815.41	958.03	1738.4	1659.11	1300.23	812.02	20861.4
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	1488.4	4093.95	4000	458.38	2459.38	1079.15	815.41	958.03	1738.4	1659.11	1300.23	812.02	20861.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
56 – Cameco, Refinery, Blind River	Days of Discharge	28.00	31.00	30.00	31.00	20.00	0.00	0.00	0.00	22.00	29.00	31.00	31.00	253
SR 0300	Present Monthly Loadings, kg	811.07	524.83	568.34	1225.57	975.89	0.00	0.00	0.00	664.72	413.28	270.16	543.97	5697.8
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	284.58	331.08	255.36	293.92	235.17	0	0	0	231.21	300.93	270.16	317.91	2520.3
	Reduction in Loadings	526.482	193.5545	312.9771	931.6447	440.7198	0	0	0	433.5117	112.3483	0	226.0659	3177.3
	% Reduction	64.91	36.89	55.07	76.02	65.21	0.00	0.00	0.00	65.22	27.18	0.00	41.56	55.8

Total suspended solids

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
57 – Cameco, Refinery, Port Hope	Days of Discharge	28	31	30	31	27	0	0	0	21	30	31	31	260
SR 0100	Present Monthly Loadings, kg	5142.94	14433.76	7043.88	9842.67	6556.85	0	0	0	30660	4490.02	10921.72	20532.82	109424.5
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	5142.94	9269.41	7043.88	9842.67	6556.85	0	0	0	6300	4490.02	7973.82	8421.58	64841.2
	Reduction in Loadings	0	5164.385	0	0	0	0	0	0	24360	0	2947.897	12111.04	44583.3
	% Reduction	0.00	35.78	0.00	0.00	0.00	0.00	0.00	0.00	79.45	0.00	26.99	58.98	40.7
57 – Cameco, Refinery, Port Hope	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
SR 0200	Present Monthly Loadings, kg	535.98	11471	931.03	842.41	318.73	0	0	0	68.25	307.9	563.59	391.27	15430.2
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	535.98	1020.94	931.03	842.41	318.73	0	0	0	68.25	307.9	547.01	391.27	4963.5
	Reduction in Loadings	0	10450.06	0	0	0	0	0	0	0	0	16.576	0	10466.6
	% Reduction	0.00	91.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.94	0.00	67.8
57 – Cameco, Refinery, Port Hope	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
SR 0300	Present Monthly Loadings, kg	334.58	735.24	291.08	162.84	117.44	0	0	0	73.74	153.77	492.39	248.24	2609.4
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	334.58	374.76	291.08	162.84	117.44	0	0	0	73.74	140.65	169.28	248.24	1912.7
	Reduction in Loadings	0	360.4825	0	0	0	0	0	0	0	13.1269	323.1327	0	696.7
	% Reduction	0.00	49.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.54	65.62	0.00	26.7
58 – Rio Algom, Stanleigh	Days of Discharge	28.00	27.50	28.45	31.00	25.71	25.04	17.42	13.50	31.00	25.71	27.86	29.99	309.18
SR 0100	Present Monthly Loadings, kg	4045.4	6246.37	3870.03	4540.22	4340.09	3932.23	2905.32	2334.88	6756.76	3751.24	8455.08	8451.07	59628.7
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	4045.4	6246.37	3870.03	4540.22	4340.09	3932.23	2905.32	2334.88	6756.76	3751.24	8455.08	8451.07	59628.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
59 – Denison Mines, Stanrock	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
SW 0100	Present Monthly Loadings, kg	595.08	348.13	1187.82	376.22	11.04	171.37	126.88	48.8	187.86	487.32	748.85	127.1	4415.7
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L	595.08	348.13	1187.82	376.22	11.04	171.37	126.88	48.8	187.86	487.32	748.85	127.1	4415.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Days of Discharge													0
	Present Monthly Loadings, kg													0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 15 mg/L													0.0
	Reduction in Loadings													0.0
	% Reduction													ERR
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Copper

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total Year
01 – INCO, Copper Cliff T.P. PR 0100	Days of Discharge	29	31	30	31	30	30	31	30	31	30	31	31	364
	Present Monthly Loadings, kg	240.19	591.78	430.84	828.61	764.33	500.8	325.24	537.81	1106.51	990.69	935.55	494.85	7747.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	240.19	591.78	430.84	828.61	764.33	500.8	325.24	537.81	1106.51	854.04	935.55	494.85	7610.5
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	136.65	0.00	0.00	136.6
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.79	0.00	0.00	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	240.19	369.14	327.35	384.89	320.7	230.54	213.54	249.95	390.17	284.86	340.3	269.33	3620.8
	Reduction in Loadings	0.00	222.62	103.49	443.72	443.63	270.26	111.70	287.88	716.34	706.01	595.25	225.52	4126.4
	% Reduction	0	37.62	24.02	53.55	58.04	53.97	34.34	53.52	64.74	71.26	63.63	45.57	53.3
02 – INCO, Crean Hill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.52	1.01	0.98	1.16	1.25	0.39	0.12	0.22	0.6	1.13	0.67	0.4	8.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.52	1.01	0.98	1.16	1.25	0.39	0.12	0.22	0.6	1.13	0.67	0.4	8.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.52	1.01	0.98	1.16	1.25	0.39	0.12	0.22	0.6	1.13	0.67	0.4	8.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
03 – Falconbridge, Falconbridge PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	7.12	28.34	13.2	11.58	9.18	6.8	2.47	2.71	6.91	9.71	15.68	4.39	117.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	7.12	28.34	13.2	11.58	9.18	6.8	2.47	2.71	6.91	9.71	15.68	4.39	117.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	7.12	28.34	13.2	11.58	9.18	6.8	2.47	2.71	6.91	9.71	15.68	4.39	117.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
04 – INCO, Garson Mine MW 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	0.42	1.78	0.57	1.34	0.44	0.58	0.49	0.43	0.91	1.96	5.3	0.51	14.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.42	1.78	0.57	1.34	0.44	0.58	0.49	0.43	0.91	1.96	5.3	0.51	14.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.42	1.78	0.57	1.34	0.44	0.58	0.49	0.43	0.91	1.96	5.3	0.51	14.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
05 – Norands Minerals, Geco Division PR 0100	Days of Discharge	28.00	21.15	29.25	30.29	29.90	29.67	20.19	28.04	30.57	29.17	29.99	30.04	336.48
	Present Monthly Loadings, kg	20.64	22.19	30.09	29.62	19.4	27.89	27.18	9.73	21.62	17.62	97.64	42.3	383.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	20.64	22.19	30.09	29.62	19.4	27.89	27.18	9.73	21.62	17.62	56.24	42.3	321.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.40	0.00	41.4
	% Reduction	0	0	0	0	0	0	0	0	0	0	42.4	0	11.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	14.4	10.72	18.61	18.61	16.51	17.56	14.12	9.73	19.31	17.62	18.75	15.29	191.8
	Reduction in Loadings	6.24	11.48	11.26	8.31	2.89	10.13	13.06	0.00	2.32	0.00	78.89	27.01	171.8
	% Reduction	30.23	51.67	37.5	30.88	14.89	36.59	48.05	0	10.71	0	80.8	63.88	47.2
06 – Falconbridge, Kidd Creek Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	4.99	15.77	31.97	62.63	26.57	23.34	8.91	18.42	52.62	62.67	10.9	7.82	356.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	4.99	15.77	31.97	62.63	26.57	23.34	8.91	18.42	52.62	62.67	10.9	7.82	356.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.99	15.77	31.97	58.76	26.57	23.34	8.91	18.42	52.62	81.8	10.9	7.82	321.5
	Reduction in Loadings	0.00	0.00	0.00	4.07	0.00	0.00	0.00	0.00	0.00	31.07	0.00	0.00	35.1
	% Reduction	0	0	0	6.48	0	0	0	0	0	33.53	0	0	9.9

Copper

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
07 – INCO, Levack Mine MW 0100	Days of Discharge	28	30	30	31	30	31	31	30	29	15	31	31	347
	Present Monthly Loadings	0.6	2.55	0.83	2.39	1.84	2.96	0.23	0.24	0.41	6.73	1.51	1.29	21.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.6	2.55	0.83	2.39	1.84	2.96	0.23	0.24	0.41	6.73	1.51	1.29	21.8
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.6	2.55	0.83	2.39	1.84	2.96	0.23	0.24	0.41	6.73	1.51	1.29	21.8
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
08 – Falconbridge, Lockerby MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	0.25	0.54	0.5	0.37	0.38	0.56	0.13	0.6	0.25	0.5	0.62	0.26	5.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.25	0.54	0.5	0.37	0.38	0.56	0.13	0.6	0.25	0.5	0.62	0.26	5.4
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.25	0.54	0.5	0.37	0.38	0.56	0.13	0.6	0.25	0.5	0.62	0.26	5.4
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
09 – Falconbridge, Metallurgical PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	55.05	222.55	35.74	20.97	12.45	38.76	14.22	23.83	32.38	1763.34	1040.39	2401.52	5661.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	55.05	222.55	35.74	20.97	12.45	38.76	14.22	23.83	32.38	408.08	328	336.68	1529.7
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1355.26	714.39	2061.85	4131.5
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.86	68.66	85.86	73.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	55.05	222.55	35.74	20.97	12.45	38.76	14.22	23.83	32.38	136.03	108.67	113.22	813.8
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1627.31	931.88	2288.29	4847.3
	% Reduction	0	0	0	0	0	0	0	0	0	92.29	89.55	85.29	85.6
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings	7.99	16.24	7.14	7.3	8	1.62	18.76	6.1	8.33	20.72	20.4	21.2	148.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	7.99	16.24	7.14	7.3	8	1.62	18.76	6.1	8.33	20.72	20.4	21.2	148.6
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	7.99	10.67	7.14	7.3	8	1.62	9.1	6.1	8.33	13.95	11.62	11.47	105.5
	Reduction In Loadings	0.00	7.58	0.00	0.00	0.00	0.00	10.67	0.00	0.00	6.77	8.58	8.73	43.3
	% Reduction	0	41.48	0	0	0	0	53.67	0	0	32.68	42.06	45.69	29.1
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	10.53	248.2	83.33	319.32	3.24	586.57	34.98	36.29	1017.48	105.95	1654.05	2.38	4312.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	10.53	248.2	83.33	129.48	3.24	200.68	34.98	36.29	116.08	105.95	156.24	2.38	1137.6
	Reduction In Loadings	0.00	0.00	0.00	189.87	0.00	385.88	0.00	0.00	901.43	0.00	1897.81	0.00	3174.8
	% Reduction	0	0	0	59.48	0	65.75	0	0	88.59	0	91.57	0	73.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	10.53	69.28	76.5	43.15	3.24	68.96	34.98	36.29	38.88	48.6	52.08	2.38	502.7
	Reduction In Loadings	0.00	156.92	16.83	276.17	0.00	518.61	0.00	0.00	876.61	57.35	1901.97	0.00	3809.7
	% Reduction	0	84.03	16.03	66.48	0	68.58	0	0	96.2	54.13	97.18	0	88.3
12 – Falconbridge, Onaping MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	0.28	0.55	0.42	0.22	0.39	0.63	0.25	0.1	0.15	0.57	0.42	0.29	4.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.28	0.55	0.42	0.22	0.39	0.63	0.25	0.1	0.15	0.57	0.42	0.29	4.3
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.28	0.55	0.42	0.22	0.39	0.63	0.25	0.1	0.15	0.57	0.42	0.29	4.3
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Copper

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total/ Year
13 – INCO, Refinery, Port Colborne	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
SR 0100	Present Monthly Loadings	22.71	52.3	53.28	97.45	29.48	11.7	8.57	37.28	169.75	44.48	57.45	34.91	839.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	22.71	52.3	53.28	97.45	29.48	11.7	8.57	37.28	108.88	44.48	57.45	34.91	558.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.07	0.00	0.00	0.00	61.1
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.73	0.00	0.00	0.00	12.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	22.71	30.19	38.44	38.44	29.48	11.7	8.57	31.48	36.23	27.47	34.19	33.71	338.8
	Reduction in Loadings	0.00	22.12	19.85	91.01	0.00	0.00	0.00	5.79	153.53	16.89	23.25	1.20	300.7
	% Reduction	0	42.29	31.81	82.81	0	0	0	15.51	80.91	38.21	40.48	3.45	47.0
14 – INCO, Shebandowen Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings	0.49	1.04	1.19	2.22	2.09	0.77	0.38	0.54	0.82	0.79	0.88	1.05	12.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.49	1.04	1.19	2.22	2.09	0.77	0.38	0.54	0.82	0.79	0.88	1.05	12.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.49	1.04	1.19	2.22	2.09	0.77	0.38	0.54	0.82	0.79	0.88	1.05	12.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15 – Falconbridge, Strathcona	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	18.00	23.00	31.00	260
PR 0100	Present Monthly Loadings	8.71	53.19	41	32.28	17.77	24.81	5.91	0	0	10.08	5.13	3.19	202.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	8.71	53.19	41	32.28	17.77	24.81	5.91	0	0	10.08	5.13	3.19	202.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	8.71	53.19	41	32.28	17.77	24.81	5.91	0	0	10.08	5.13	3.19	202.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
16 – INCO, Whistle Mine	Days of Discharge	0	11	18	31	30	29	0	0	22	30	31	14	214
MW 0100	Present Monthly Loadings	0	1.1	0.18	0.33	0.09	0.2	0	0	4.41	2.12	1.08	0.17	9.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	1.1	0.18	0.33	0.09	0.2	0	0	4.41	2.12	1.08	0.17	9.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.73	0.18	0.33	0.09	0.2	0	0	2.99	1.93	1.08	0.11	7.3
	Reduction in Loadings	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	1.71	0.20	0.00	0.06	2.3
	% Reduction	0	33.92	0	0	0	0	0	0	38.85	9.3	0	34.73	24.2
17 – Minnova, Winston Lake Mine	Days of Discharge	0.00	0.00	0.00	31.00	30.00	31.00	31.00	15.00	27.00	15.00	31.00	31.00	242
PR 0100	Present Monthly Loadings	0	0	0	1.74	2.12	1.78	0.78	0.28	1.87	0.25	0.42	0.83	9.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	1.74	2.12	1.78	0.78	0.28	1.87	0.25	0.42	0.83	9.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	1.74	2.12	1.78	0.78	0.28	1.87	0.25	0.42	0.83	9.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
19 – Dickenson, Arthur W. White Mine	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	318
PR 0100	Present Monthly Loadings	75.38	213.08	111.04	0	1734.74	1280.88	853.73	748.08	504.74	173.88	90.42	88.4	5850.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	46.87	109.42	50.73	0	542.74	725.03	693.88	686.93	411.47	121.54	58.78	42.45	3489.4
	Reduction in Loadings	28.71	103.64	60.31	0.00	1192.01	555.85	160.09	59.15	93.27	52.33	33.83	23.95	2360.9
	% Reduction	35.43	48.64	54.31	0.00	68.71	43.40	18.75	7.93	18.48	30.10	37.20	36.07	40.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	18.22	38.47	18.91	0	180.91	241.66	231.22	229.98	137.16	40.51	19.93	14.15	1183.1
	Reduction in Loadings	59.19	178.59	94.13	0.00	1553.83	1039.20	622.51	517.10	367.58	133.35	71.49	52.25	4667.2
	% Reduction	78.48	82.88	84.77	0	89.57	81.13	72.92	69.31	72.83	76.7	79.07	78.89	80.1

Copper

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total Year
21 – Canamax, Bell Creek Mine	Days of Discharge	0	0	0	0	0	0	31	23	31	0	0	0	85
PR 0100	Present Monthly Loadings	0	0	0	0	0	0	7.73	3.98	15.26	0	0	0	27.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	0	0	0	7.73	3.98	13.48	0	0	0	25.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.00	1.8
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.76	0.00	0.00	0.00	6.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	3.52	1.66	4.49	0	0	0	9.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	4.22	2.32	10.76	0.00	0.00	0.00	17.3
	% Reduction	0	0	0	0	0	0	54.55	58.33	70.56	0	0	0	64.2
24 – Teck – Corone, David Bell Mine	Days of Discharge	25.00	6.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	264
PR 0100	Present Monthly Loadings	3.87	1.41	0	0.55	0.36	0.31	0.66	0.45	0.17	0.37	0.92	0.76	9.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	3.87	1.41	0	0.55	0.36	0.31	0.66	0.45	0.17	0.37	0.92	0.76	9.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.87	1.06	0	0.55	0.36	0.31	0.66	0.45	0.17	0.37	0.92	0.76	9.5
	Reduction in Loadings	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4
	% Reduction	0	24.81	0	0	0	0	0	0	0	0	0	0	3.6
25 – Placer Dome, Detour Lake Mine	Days of Discharge	26.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings	57.23	73.08	219.61	1761.08	363.25	128.65	0.45	1.85	741.67	424.51	86.62	41.14	3917.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	45.08	66.6	191.81	1149.08	306.26	86.66	0.44	1.85	741.67	418.06	86.62	41.14	3147.6
	Reduction in Loadings	12.15	6.49	28.00	631.99	57.00	27.96	0.01	0.00	0.00	6.43	0.00	0.00	770.0
	% Reduction	21.23	8.88	12.75	35.48	15.68	22.06	1.26	0.00	0.00	1.52	0.00	0.00	19.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	15.03	22.2	63.67	363.03	102.06	32.6	0.15	0.72	267.6	136.36	45.38	25.04	1097.7
	Reduction in Loadings	42.20	50.88	155.74	1398.05	261.17	93.75	0.30	1.14	473.67	285.15	41.54	16.10	2820.0
	% Reduction	73.74	69.63	70.92	79.49	71.8	74.03	67.06	61.42	63.89	67.17	47.79	38.13	72.0
26 – Placer Dome, Dome Mine	Days of Discharge	26	31	30	31	30	31	31	30	31	30	5	23	331
PR 0100	Present Monthly Loadings	97.83	319.69	1034.05	400.09	124.59	110.43	129.63	74.11	83.79	74.27	12.33	65.5	2526.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	88.21	210.21	482.63	311.75	124.59	110.43	129.63	74.11	83.79	74.27	12.33	65.5	1767.7
	Reduction in Loadings	9.73	109.48	551.23	88.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	758.6
	% Reduction	9.83	34.25	53.31	22.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	29.4	70.07	160.84	103.62	46.56	56.34	76.56	50.25	62.53	50.64	8.6	36.22	754.1
	Reduction in Loadings	68.53	248.62	873.11	296.17	78.01	54.09	51.07	23.67	21.26	23.63	3.73	29.28	1772.4
	% Reduction	69.88	78.08	84.44	74.03	62.62	48.98	39.39	32.2	25.37	31.82	30.23	44.7	70.2
27 – Placer Dome, Dona Lake Mine	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
PR 0100	Present Monthly Loadings	0	0	0	1.37	8.73	1.66	0	0	1.71	4.27	0	0	17.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	1.37	8.73	1.66	0	0	1.71	4.27	0	0	17.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	1.37	8.73	1.66	0	0	1.71	4.27	0	0	17.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28 – Eastmaque Gold Mines	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings	0.2	3.61	26.29	10.97	2.64	3.18	1.12	2.31	4.77	3.8	1.75	0.58	63.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.2	3.61	26.29	10.97	2.64	3.18	1.12	2.31	4.77	3.8	1.75	0.58	63.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.2	3.61	26.29	10.97	2.64	3.18	1.12	2.31	4.77	3.8	1.75	0.58	63.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Copper

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-80	Mar-80	Apr-80	May-80	Jun-80	Jul-80	Aug-80	Sep-80	Oct-80	Nov-80	Dec-80	Jan-81	Total Year
29 – Giant Yellowknife, ERG Res.	Days of Discharge	0	0	27	0	0	0	0	0	13	0	0	0	40
PR 0100	Present Monthly Loadings	0	0	272.18	0	0	0	0	0	75.19	0	0	0	347.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	233.28	0	0	0	0	0	75.19	0	0	0	308.5
	Reduction in Loadings	0.00	0.00	38.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.9
	% Reduction	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	77.78	0	0	0	0	0	75.19	0	0	0	153.0
	Reduction in Loadings	0.00	0.00	194.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	194.4
	% Reduction	0	0	71.43	0	0	0	0	0	0	0	0	0	56.0
30 – Hemlo Gold Mines, Golden Giant	Days of Discharge	0.00	0.00	0.00	0.00	0.00	18.00	31.00	30.00	31.00	30.00	31.00	18.00	188
PR 0100	Present Monthly Loadings	0	0	0	0	0	8.12	11.84	2.72	4.27	2	2.78	2.48	32.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	0	0	8.12	11.84	2.72	4.27	2	2.78	2.48	32.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	8.12	11.84	2.72	4.27	2	2.78	2.48	32.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
31 – Canamax, Kremzar Mine	Days of Discharge	0.00	0.00	18.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32
PR 0100	Present Monthly Loadings	0	0	1.15	1.51	0	0	0	0	0	0	0	0	2.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	1.15	1.51	0	0	0	0	0	0	0	0	2.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	1.15	1.51	0	0	0	0	0	0	0	0	2.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 – LAC Minerals, Macassa Division	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
PR 0100	Present Monthly Loadings	12.63	203.34	164.4	3710.67	24.78	35.84	2.82	0.8	3.17	21.61	17.24	2.43	4200.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	12.63	52.49	82.41	1781.06	24.78	35.84	2.82	0.8	3.17	21.61	17.24	2.43	2017.4
	Reduction in Loadings	0.00	150.86	81.99	1648.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2182.8
	% Reduction	0.00	74.19	49.87	52.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.86	17.49	27.47	587.03	20.37	28.81	2.82	0.8	3.17	21.81	17.24	2.43	731.8
	Reduction in Loadings	7.88	185.85	136.93	3123.64	4.41	6.23	0.00	0.00	0.00	0.00	0.00	0.00	3468.2
	% Reduction	63.08	91.4	83.29	84.18	17.81	25.74	0	0	0	0	0	0	82.8
35 – Canamax, Marhill Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
MW 0100	Present Monthly Loadings	1.03	1.41	0.86	0.43	0.15	0.4	0.25	0.1	0.11	0.34	0.54	0.43	6.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	1.03	1.41	0.86	0.43	0.15	0.4	0.25	0.1	0.11	0.34	0.54	0.43	6.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.03	1.41	0.86	0.43	0.15	0.4	0.25	0.1	0.11	0.34	0.54	0.43	6.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
36 – American Barrick, McDermott	Days of Discharge	0.00	11.00	27.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
PR 0100	Present Monthly Loadings	0	58.81	73.25	29.85	0	0	0	0	0	0	0	0	161.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	58.81	73.25	29.85	0	0	0	0	0	0	0	0	161.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	30.45	73.25	29.85	0	0	0	0	0	0	0	0	133.7
	Reduction in Loadings	0.00	28.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.2
	% Reduction	0	48.05	0	0	0	0	0	0	0	0	0	0	17.4

Copper

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
37 – Bond Gold, Muskegsagegen Lake PR 0100	Days of Discharge	28	0	0	31	30	31	31	30	0	30	31	31	273
	Present Monthly Loadings	0.03	0	0	0.46	0.52	0.15	0.31	0.07	0	0.3	0.07	0.02	1.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.03	0	0	0.46	0.52	0.15	0.31	0.07	0	0.3	0.07	0.02	1.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.03	0	0	0.46	0.52	0.15	0.31	0.07	0	0.3	0.07	0.02	1.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine MW 0100	Days of Discharge	28.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56
	Present Monthly Loadings	0.43	0.5	0	0	0	0	0	0	0	0	0	0	0.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.43	0.5	0	0	0	0	0	0	0	0	0	0	0.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.43	0.5	0	0	0	0	0	0	0	0	0	0	0.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine PR 0200	Days of Discharge	0.00	0.00	0.00	10.00	28.00	31.00	31.00	30.00	17.00	0.00	0.00	0.00	148
	Present Monthly Loadings	0	0	0	16.58	23.4	5.88	7.43	16.38	10.89	0	0	0	80.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	16.58	23.4	5.88	7.43	16.38	10.89	0	0	0	80.5
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	10.41	23.4	5.88	7.43	16.38	10.89	0	0	0	74.4
	Reduction in Loadings	0.00	0.00	0.00	6.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.1
	% Reduction	0	0	0	37.11	0	0	0	0	0	0	0	0	7.6
39 – Giant Yellowknife, Pamour #1 PR 0100	Days of Discharge	28	31	30	31	30	31	31	15	31	30	0	21	309
	Present Monthly Loadings	61.98	34.67	13.66	6.84	2.34	4.53	1.09	0.13	0.98	0.66	0	0.32	127.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	24.54	34.67	13.66	6.84	2.34	4.53	1.09	0.13	0.98	0.66	0	0.32	90.1
	Reduction in Loadings	37.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.4
	% Reduction	60.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	8.18	22.37	13.66	6.84	2.34	4.53	1.09	0.13	0.98	0.66	0	0.32	61.4
	Reduction in Loadings	53.80	12.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.1
	% Reduction	86.8	35.48	0	0	0	0	0	0	0	0	0	0	51.8
39 – Giant Yellowknife, Pamour #1 PR 0200	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
	Present Monthly Loadings	0	0	0	0	0	0	0	0.15	1.67	0.04	0	0	1.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	0	0	0	0	0.15	1.67	0.04	0	0	1.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	0	0.15	1.67	0.04	0	0	1.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
42 – Renable Gold Mines PR 0100	Days of Discharge	0.00	14.00	0.00	28.00	28.00	30.00	1.00	5.00	0.00	0.00	0.00	0.00	104
	Present Monthly Loadings	0	171.41	0	61.79	48.95	50.33	0.3	0.98	0	0	0	0	353.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	146.92	0	74.35	38.65	50.33	0.3	0.98	0	0	0	0	311.5
	Reduction in Loadings	0.00	24.49	0.00	7.44	10.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.2
	% Reduction	0.00	14.29	0.00	9.09	21.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	48.97	0	24.76	12.88	17.98	0.16	0.98	0	0	0	0	105.8
	Reduction in Loadings	0.00	122.44	0.00	57.00	36.07	32.36	0.14	0.00	0.00	0.00	0.00	0.00	248.0
	% Reduction	0	71.43	0	69.7	73.68	64.29	47.37	0	0	0	0	0	70.1

Copper

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
45 – St. Andrews Gold Fields PR 0100	Days of Discharge	0	0	0	0	0	28	31	30	31	29	0	0	147
	Present Monthly Loadings	0	0	0	0	0	7.45	3.92	1.64	8.58	8.2	0	0	27.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	0	0	0	0	7.45	3.92	1.64	8.58	8.2	0	0	27.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	3.62	2.8	1.64	8.6	2.95	0	0	17.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	3.53	1.12	0.00	1.98	3.25	0.00	0.00	9.9
	% Reduction	0	0	0	0	0	47.37	28.57	0	23.08	52.38	0	0	35.5
48 – Algoma Steel, Ore Division PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	180
	Present Monthly Loadings	2.8	3.4	3.07	2.85	1.88	2.82	0	0	0	0	0	0	16.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	2.8	3.4	3.07	2.85	1.88	2.82	0	0	0	0	0	0	16.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.8	3.4	3.07	2.85	1.68	2.82	0	0	0	0	0	0	16.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	8.9	2.07	8.2	2	4.71	3.62	1.52	1.63	2.83	3.85	42.03	14.57	84.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	8.9	2.07	8.2	2	4.71	3.62	1.52	1.63	2.83	3.85	42.03	14.57	84.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	8.9	2.07	8.2	2	4.71	3.62	1.52	1.63	2.83	3.85	42.03	14.57	84.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property SW 0200	Days of Discharge	28	31	30	31	30	31	23	16	31	30	31	31	343
	Present Monthly Loadings	0.01	0.01	0.1	0.02	0.02	0.03	0.01	0.01	0.02	0.03	1.24	0.09	1.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.01	0.01	0.1	0.02	0.02	0.03	0.01	0.01	0.02	0.03	1.24	0.09	1.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.01	0.01	0.1	0.02	0.02	0.03	0.01	0.01	0.02	0.03	1.24	0.09	1.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
52 – Rio Algom, Lacnor/Nordic SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	0.58	8.65	5.67	1.79	0.22	1.03	0.04	0.03	0.73	9.02	1.88	1.67	29.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.58	8.65	5.67	1.79	0.22	1.03	0.04	0.03	0.73	9.02	1.88	1.67	29.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.58	8.65	5.67	1.79	0.22	1.03	0.04	0.03	0.73	9.02	1.88	1.67	29.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel SR 0100	Days of Discharge	28.00	31.00	30.00	30.67	29.67	31.00	31.00	30.00	22.89	21.21	28.00	25.21	338.45
	Present Monthly Loadings	3.03	7.67	3.61	6.88	3.12	3.88	3.1	2.12	4.57	2.91	2.08	4.04	46.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	3.03	7.67	3.61	6.88	3.12	3.88	3.1	2.12	4.57	2.91	2.08	4.04	46.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.03	7.67	3.61	6.88	3.12	3.88	3.1	2.12	4.57	2.91	2.08	4.04	46.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Copper

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
54 – Rio Algom, Pronto SW 0100	Days of Discharge	0	12	29.87	31	28.25	0	11	0	0	0	21	0	132.92
	Present Monthly Loadings	0	5.33	5.74	0.83	1.14	0	2	0	0	0	5.75	0	20.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0	5.33	5.74	0.83	1.14	0	2	0	0	0	5.75	0	20.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	5.33	5.74	0.83	1.14	0	2	0	0	0	5.75	0	20.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
55 – Rio Algom, Quirke PR 0100	Days of Discharge	28.00	31.00	30.00	0.00	30.00	31.00	30.00	30.00	30.50	27.70	19.42	23.92	311.54
	Present Monthly Loadings	7.04	14.12	8.36	0	18.04	3.2	6.31	5.87	19.2	13.31	22.16	7.26	126.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	7.04	14.12	8.39	0	18.04	3.2	6.31	5.87	19.2	13.31	22.16	7.26	126.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	7.04	14.12	8.39	0	18.04	3.2	6.31	5.87	19.2	13.31	22.16	7.26	126.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
56 – Cameco, Refinery, Blind River SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	20.00	0.00	0.00	0.00	22.00	28.00	31.00	31.00	253
	Present Monthly Loadings	0.08	0.04	0.03	0.08	0.08	0	0	0	0.08	1.5	0.04	0.34	2.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.09	0.04	0.03	0.08	0.08	0	0	0	0.09	1.5	0.04	0.34	2.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.09	0.04	0.03	0.08	0.08	0	0	0	0.08	1.5	0.04	0.34	2.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0100	Days of Discharge	28	31	30	31	27	0	0	0	21	30	31	31	260
	Present Monthly Loadings	1.08	1.24	0.88	88.68	3.37	0	0	0	0.84	7.17	4.78	1.12	109.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	1.08	1.24	0.88	88.68	3.37	0	0	0	0.84	7.17	4.78	1.12	109.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.08	1.24	0.88	68.23	3.37	0	0	0	0.84	7.17	4.78	1.12	88.8
	Reduction in Loadings	0.00	0.00	0.00	20.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.5
	% Reduction	0	0	0	23.08	0	0	0	0	0	0	0	0	18.7
57 – Cameco, Refinery, Port Hope SR 0200	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings	2.25	0.14	0.15	0.14	0.23	0	0	0	0.1	0.38	0.29	0.08	3.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	2.25	0.14	0.15	0.14	0.23	0	0	0	0.1	0.38	0.29	0.08	3.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.25	0.14	0.15	0.14	0.23	0	0	0	0.1	0.38	0.29	0.08	3.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings	0.05	0.05	0.34	0.08	0.04	0	0	0	0.03	0.17	0.09	0.04	0.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.05	0.05	0.34	0.08	0.04	0	0	0	0.03	0.17	0.09	0.04	0.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.05	0.05	0.34	0.08	0.04	0	0	0	0.03	0.17	0.09	0.04	0.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Copper

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	*Total Year*
58 – Rio Algom, Stanleigh SR 0100	Days of Discharge	28	27.5	28.45	31	25.71	25.04	0	13.5	31	25.71	27.98	29.69	291.78
	Present Monthly Loadings	5.6	10.55	4.02	12.61	5.39	4.67	0	5.2	13.43	5.53	19.38	7.1	93.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	5.6	10.55	4.02	12.61	5.39	4.67	0	5.2	13.43	5.53	19.38	7.1	93.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	5.6	10.55	4.02	12.61	5.39	4.67	0	5.2	13.43	5.53	19.38	7.1	93.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
59 – Denison Mines, Stanrock SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	0.2	0.14	1.16	0.09	0.01	0.13	0.06	0.02	0.09	0.73	7.89	0.35	10.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.3 mg/L	0.2	0.14	1.16	0.09	0.01	0.13	0.06	0.02	0.09	0.73	7.89	0.35	10.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.2	0.14	1.16	0.09	0.01	0.13	0.06	0.02	0.09	0.73	7.89	0.35	10.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Nickel

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total Year
01 – INCO, Copper Cliff T.P. PR 0100	Days of Discharge	28	31	30	31	30	31	30	31	30	31	31	31	364
	Present Monthly Loadings	1663.46	2003	1666.21	2291.16	2700.29	547.79	764.61	906.49	1969.29	4507.67	1850.39	2115.3	23007.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1512.23	1845.68	1638.73	1924.44	1603.5	547.79	764.61	906.49	1950.83	1423.4	1701.51	1346.64	17164.1
	Reduction In Loadings	151.22	157.31	31.48	366.74	1096.79	0.00	0.00	0.00	36.46	3084.27	148.88	768.66	5843.8
	% Reduction	9.09	7.85	1.89	16.01	40.62	0.00	0.00	0.00	1.93	68.42	8.05	36.34	25.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	302.45	369.14	327.35	384.89	320.7	230.54	213.54	249.95	390.17	284.68	340.3	269.33	3883.0
	Reduction In Loadings	1361.01	1633.86	1340.86	1906.26	2379.59	317.26	551.27	656.54	1599.12	4222.99	1510.09	1845.97	18324.9
	% Reduction	81.82	81.57	80.36	83.2	88.12	57.92	72.08	72.43	80.39	93.68	81.61	87.27	84.0
02 – INCO, Crean Hill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	4.99	88.22	32.16	15.61	3.62	6.84	1.42	2.54	12.48	41.17	17.3	5.88	232.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	4.99	61.6	32.16	15.61	3.62	6.84	1.42	2.54	12.48	41.17	17.3	5.88	206.3
	Reduction In Loadings	0.00	26.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.4
	% Reduction	0	29.94	0	0	0	0	0	0	0	0	0	0	11.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.24	12.36	12.48	10.24	3.62	6.17	1.42	2.54	7.47	15.1	9.18	5.2	90.2
	Reduction In Loadings	0.74	75.85	19.70	5.37	0.00	0.67	0.00	0.00	5.01	26.07	8.12	0.79	142.5
	% Reduction	14.89	85.99	61.25	35.25	0	9.79	0	0	40.12	63.33	46.95	13.19	61.2
03 – Falconbridge, Falconbridge PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	252.51	448.73	369.6	300.75	123.35	48.02	48.29	106.88	276.06	328.22	358.29	238.23	2884.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	252.51	448.73	369.6	300.75	123.35	48.02	48.29	106.88	276.06	328.22	358.29	238.23	2884.7
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	71.21	117.06	113.14	90.55	50.78	14.35	32.46	50.1	69.73	106.68	88.74	54.39	879.4
	Reduction In Loadings	181.30	331.67	256.46	210.20	72.57	31.67	15.83	56.58	186.34	221.34	269.55	183.84	2015.4
	% Reduction	71.8	73.91	69.38	69.89	58.83	68.82	29.88	53.03	67.5	67.44	75.23	77.17	69.6
04 – INCO, Garson Mine MW 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings	15.66	59.35	26.53	36.54	10.14	10.12	97.38	17.7	31.12	47	59.02	85.09	497.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	15.66	55.12	26.53	36.54	10.14	10.12	33.02	17.7	31.12	46.74	51.58	34.31	370.6
	Reduction In Loadings	0.00	4.22	0.00	0.00	0.00	0.00	64.35	0.00	0.00	0.26	7.44	50.78	127.1
	% Reduction	0.00	7.12	0.00	0.00	0.00	0.00	66.08	0.00	0.00	0.56	12.61	59.68	25.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	5.05	11.02	7.54	9.06	6.33	7.87	6.6	5.62	10.06	9.35	10.32	6.88	96.0
	Reduction In Loadings	10.62	48.32	18.99	29.48	3.80	2.25	90.76	11.78	21.06	37.65	48.71	78.23	401.8
	% Reduction	67.79	81.42	71.59	76.45	37.5	22.27	93.22	66.55	67.67	80.11	82.52	91.94	80.7
05 – Norands Minerals, Geco Division PR 0100	Days of Discharge	28.00	21.15	29.25	30.29	29.90	29.67	20.19	28.04	30.57	29.17	29.99	30.04	336.46
	Present Monthly Loadings	1.44	1.07	1.66	1.66	2.34	1.76	1.41	1.65	8.24	2.02	1.87	1.53	27.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.44	1.07	1.66	1.66	2.34	1.76	1.41	1.65	8.24	2.02	1.87	1.53	27.1
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.44	1.07	1.66	1.66	2.34	1.76	1.41	1.65	8.24	2.02	1.87	1.53	27.1
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
06 – Falconbridge, Kidd Creek Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	1.76	8.95	7.77	5.86	5.53	4.2	2.81	5.11	8.63	8.57	3.1	2.87	60.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.76	8.95	7.77	5.86	5.53	4.2	2.81	5.11	8.63	8.57	3.1	2.87	60.6
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.76	8.95	7.77	5.86	5.53	4.2	2.81	5.11	8.63	8.57	3.1	2.87	60.6
	Reduction In Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Nickel

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
07 – INCO, Levack Mine MW 0100	Days of Discharge	28	30	30	31	30	31	31	30	29	15	31	31	347
	Present Monthly Loadings	17.24	42.7	14.62	47.37	31.53	100.9	15.38	7.38	13.43	169.38	211.7	147.88	619.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	17.24	42.7	14.62	28.76	31.53	32.45	6.56	7.38	13.43	55.83	37.74	34.16	322.4
	Reduction in Loadings	0.00	0.00	0.00	20.58	0.00	68.45	8.82	0.00	0.00	113.53	173.96	113.70	497.1
	% Reduction	0.00	0.00	0.00	43.48	0.00	67.84	44.35	0.00	0.00	67.04	82.17	76.88	60.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	7.3	10	9.14	5.36	6.55	6.48	1.71	2.65	4.1	11.17	7.55	6.84	79.9
	Reduction in Loadings	9.94	32.71	5.48	42.02	24.98	94.41	13.67	4.73	9.32	158.19	204.16	141.05	740.7
	% Reduction	57.66	76.59	37.5	88.7	79.23	93.57	88.87	64.08	69.44	93.41	96.43	95.38	90.4
08 – Falconbridge, Lockerby MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	2.9	8.03	5.78	4.62	1.7	3.12	2.05	2.14	9.08	14.57	13.67	9.17	76.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	2.9	8.03	5.78	4.62	1.7	3.12	2.05	2.14	9.08	14.57	13.67	9.17	76.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.58	4.63	4.31	4.34	1.7	3.12	2.05	2.14	4.71	6.5	5.41	4.5	45.0
	Reduction in Loadings	1.33	3.40	1.47	0.28	0.00	0.00	0.00	0.00	4.37	8.07	8.27	4.66	31.8
	% Reduction	45.7	42.31	25.47	6.04	0	0	0	0	48.1	55.39	60.48	50.66	41.4
09 – Falconbridge, Metallurgical PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	32.5	55.75	43.34	14.76	15.88	19.14	8.52	11.77	19.27	17.91	14.83	31.44	265.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	32.5	55.75	43.34	14.76	15.88	19.14	8.52	11.77	19.27	17.91	14.83	31.44	265.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	32.5	55.75	43.34	14.79	15.88	19.14	8.52	11.77	19.27	17.91	14.83	31.44	265.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings	78.78	130.75	92.35	59.95	75.03	8.3	49.77	83.97	114.58	126.98	129.32	49.3	977.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	48.65	53.37	50.1	53.48	68.75	8.3	45.52	50.39	65.08	69.77	59.11	49.3	620.8
	Reduction in Loadings	30.14	77.37	42.25	6.48	5.28	0.00	4.24	13.58	49.48	57.19	70.21	0.00	356.2
	% Reduction	38.25	59.18	45.75	10.76	7.03	0.00	8.53	21.23	43.19	45.04	54.29	0.00	36.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	9.33	10.67	10.02	10.7	13.95	3.62	9.1	10.08	13.02	13.85	11.62	11.47	127.8
	Reduction in Loadings	67.48	120.07	82.33	49.26	61.08	4.48	40.66	53.89	101.54	113.00	117.48	37.83	849.1
	% Reduction	87.85	91.84	89.15	82.16	81.41	53.95	81.71	84.25	88.64	89.01	90.86	76.73	86.9
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	43.06	699.38	408.51	1294.56	750.9	2772.14	406.41	230.86	3110.52	738.72	5885.04	12.35	16349.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	43.06	446.4	382.5	215.76	270	334.8	178.7	230.86	193.44	243	260.4	12.35	2809.4
	Reduction in Loadings	0.00	249.96	26.01	1078.80	480.80	2437.34	229.71	0.00	2917.08	495.72	5624.64	0.00	13539.9
	% Reduction	0	35.9	6.37	83.33	64.03	87.92	56.52	0	93.78	67.11	95.58	0	82.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	15.96	69.26	76.5	43.15	54	66.96	35.34	57.8	38.89	48.6	52.08	7.44	565.6
	Reduction in Loadings	27.13	607.10	332.01	1251.41	696.80	2705.18	371.07	173.36	3071.83	690.12	5832.96	4.81	15783.7
	% Reduction	62.88	87.18	81.27	96.67	92.81	97.58	91.3	75.08	98.76	93.42	99.12	38.78	96.4
12 – Falconbridge, Oneping MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	13.34	9.76	5.01	4.32	10.08	6.15	4.9	2.16	4.42	22.8	8.94	7.04	99.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	13.34	9.76	5.01	4.32	10.08	6.15	4.9	2.16	4.42	22.8	8.94	7.04	99.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.83	4.41	4.2	3.37	2.4	2.45	2.69	2.16	2.64	4.82	3.14	3.48	38.7
	Reduction in Loadings	10.51	5.36	0.81	0.95	7.68	3.70	2.20	0.00	1.79	17.98	5.80	3.56	60.3
	% Reduction	78.78	54.89	16.06	22.01	76.21	60.11	45.01	0	40.36	78.51	64.91	50.53	60.8

Nickel

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total Year
13 – INCO, Refinery, Port Colborne	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
SR 0100	Present Monthly Loadings	45.61	64.05	98.53	114.66	33.94	26.51	23.57	45.24	40.86	38.61	83.55	83.13	696.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	45.61	64.05	98.53	114.66	33.94	26.51	23.57	45.24	40.86	38.61	83.55	83.13	696.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	23.47	30.16	36.44	36.44	32.24	18.9	23.57	31.48	36.23	27.47	34.19	33.71	364.3
	Reduction in Loadings	22.15	53.88	60.10	78.42	1.70	7.61	0.00	13.76	4.64	11.33	48.35	29.42	332.4
	% Reduction	48.58	84.09	62.25	68.28	5.01	28.72	0	30.42	11.35	29.2	59.07	46.61	47.7
14 – INCO, Shebandowan Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings	18.26	32.03	23.68	45.66	36.7	20.85	10.09	13.43	28.66	33.36	35.06	38.42	334.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	18.26	32.03	23.68	45.66	36.7	20.85	10.09	13.43	28.66	33.36	35.06	38.42	334.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	6.24	17.32	10.29	26.05	16.66	12.19	6.28	6.55	12.7	13.16	14.61	16.07	174.4
	Reduction in Loadings	8.05	14.72	4.60	19.63	18.81	8.67	3.81	4.88	15.16	20.17	20.45	22.35	160.5
	% Reduction	48.42	45.95	16.25	43.22	45.6	41.57	37.8	36.34	56	60.48	58.33	58.17	47.9
15 – Falconbridge, Strathcona	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	18.00	23.00	31.00	280
PR 0100	Present Monthly Loadings	211.11	575.82	568.76	568.19	129.42	164.25	66.12	0	0	154.13	34.16	30.3	2525.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	211.11	275.07	568.76	568.19	129.42	164.25	66.12	0	0	154.13	34.16	30.3	2224.5
	Reduction in Loadings	0.00	300.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	300.7
	% Reduction	0.00	52.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	66.61	55.01	169.23	165.55	91.68	84.63	68.12	0	0	52.85	17.29	30.3	631.5
	Reduction in Loadings	144.50	520.81	400.53	402.64	37.52	99.62	0.00	0.00	0.00	101.29	16.88	0.00	1693.6
	% Reduction	68.45	90.45	67.81	70.88	28.99	42.38	0	0	0	65.71	48.37	0	67.1
16 – INCO, Whistle Mine	Days of Discharge	0	11	16	31	30	29	0	0	22	30	31	14	214
MW 0100	Present Monthly Loadings	0	33.25	5.67	3.83	1.34	5.37	0	0	210.42	76.24	21.2	1.88	358.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	3.64	1.33	3.83	1.34	5.37	0	0	13.47	9.63	9.46	0.55	48.6
	Reduction in Loadings	0.00	29.61	4.35	0.00	0.00	0.00	0.00	0.00	196.95	66.61	11.74	1.33	310.6
	% Reduction	0.00	89.05	76.62	0.00	0.00	0.00	0.00	0.00	93.60	87.37	55.38	70.75	86.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.73	0.27	1.27	0.75	1.45	0	0	2.68	1.83	1.88	0.11	11.1
	Reduction in Loadings	0.00	32.53	5.41	2.56	0.59	3.83	0.00	0.00	207.72	74.31	19.31	1.77	348.1
	% Reduction	0	97.81	95.32	66.88	43.83	73.07	0	0	98.72	97.47	91.06	94.15	96.8
17 – Minnove, Winston Lake Mine	Days of Discharge	0.00	0.00	0.00	31.00	30.00	31.00	31.00	15.00	27.00	15.00	31.00	31.00	242
PR 0100	Present Monthly Loadings	0	0	0	0.55	1.15	0.82	0.52	0.23	2.37	0.29	0.34	0.4	6.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0.55	1.15	0.82	0.52	0.23	2.37	0.29	0.34	0.4	6.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0.55	1.15	0.82	0.52	0.23	2.37	0.29	0.34	0.4	6.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
18 – Dickenson, Arthur W. White Mine	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	318
PR 0100	Present Monthly Loadings	67.47	237.98	120.25	0	1131.7	1237.72	1024.48	1018.94	670.24	224.84	114.44	60.15	5958.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	81.12	182.38	84.55	0	904.56	1208.36	1024.48	1018.94	670.24	202.56	84.64	70.75	5542.6
	Reduction in Loadings	16.35	55.62	35.70	0.00	227.14	29.35	0.00	0.00	0.00	22.28	19.80	9.40	415.6
	% Reduction	16.77	23.37	29.69	0.00	20.07	2.37	0.00	0.00	0.00	9.81	17.30	11.73	7.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	16.22	36.47	16.91	0	180.91	241.66	231.22	226.98	137.16	40.51	16.83	14.15	1163.1
	Reduction in Loadings	81.25	201.51	103.34	0.00	950.79	996.05	793.26	789.96	533.09	184.33	85.52	88.00	4705.1
	% Reduction	83.35	84.67	85.94	0	84.01	80.47	77.43	77.53	78.54	81.88	83.48	82.35	80.5

Nickel

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
21 – Cenemax, Bell Creek Mine	Days of Discharge	0	0	0	0	0	0	31	23	31	0	0	0	85
PR 0100	Present Monthly Loadings	0	0	0	0	0	0	8.79	3.98	15.28	0	0	0	28.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0	8.79	3.98	15.28	0	0	0	28.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	3.52	1.68	4.49	0	0	0	9.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	5.27	2.32	10.78	0.00	0.00	0.00	18.4
	% Reduction	0	0	0	0	0	0	60	58.33	70.58	0	0	0	65.5
24 – Teck – Corone, David Bell Mine	Days of Discharge	25.00	6.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	264
PR 0100	Present Monthly Loadings	2.61	0.47	0	4.06	1.73	2.52	1.23	2.66	1.01	2.8	2.85	4.73	26.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	2.61	0.47	0	4.06	1.73	2.52	1.23	2.66	1.01	2.8	2.85	4.73	26.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.61	0.47	0	4.06	1.73	2.52	1.23	2.66	1.01	2.8	2.85	4.73	26.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
25 – Placer Dome, Detour Lake Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings	5.01	5.81	17.2	87.55	23.82	8.46	0.04	0.15	66.86	33.23	7.33	3.4	288.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	5.01	5.81	17.2	87.55	23.82	8.46	0.04	0.15	66.86	33.23	7.33	3.4	288.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	5.01	5.81	17.2	87.55	23.82	8.46	0.04	0.15	66.86	33.23	7.33	3.4	288.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28 – Placer Dome, Dome Mine	Days of Discharge	28	31	30	31	30	31	31	30	31	30	5	23	331
PR 0100	Present Monthly Loadings	78.03	182.18	494.8	272.78	104.8	147.82	237.85	138.82	172.59	142.63	25.24	107.16	2102.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	78.03	182.18	494.8	272.78	104.8	147.82	237.85	138.82	172.59	142.63	25.24	107.16	2102.5
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	29.4	70.07	180.94	103.92	46.58	58.34	78.56	50.25	62.53	50.84	8.6	38.22	754.1
	Reduction in Loadings	48.63	112.11	333.85	168.87	58.22	91.28	159.09	88.57	110.06	91.99	16.64	70.94	1348.4
	% Reduction	62.32	61.54	67.46	61.9	55.56	61.83	66.84	63.3	63.77	64.5	65.91	66.2	64.1
27 – Placer Dome, Done Lake Mine	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
PR 0100	Present Monthly Loadings	0	0	0	1.31	3.27	1.86	0	0	1.63	7.12	0	0	15.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	1.31	3.27	1.86	0	0	1.63	7.12	0	0	15.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	1.31	3.27	1.86	0	0	1.63	7.12	0	0	15.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28 – Eastmeque Gold Mines	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings	0.34	5.73	13.68	12.54	3.74	2.63	1.12	2.27	4.45	3.6	1.65	0.34	52.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.34	5.73	13.68	12.54	3.74	2.63	1.12	2.27	4.45	3.6	1.65	0.34	52.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.34	5.73	13.68	12.54	3.74	2.63	1.12	2.27	4.45	3.6	1.65	0.34	52.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Nickel

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total/ Year
29 – Giant Yellowknife, ERG Res. PR 0100	Days of Discharge	0	0	27	0	0	0	0	0	13	0	0	0	40
	Present Monthly Loadings	0	0	108.66	0	0	0	0	0	69.18	0	0	0	178.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	108.66	0	0	0	0	0	69.18	0	0	0	178.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	77.76	0	0	0	0	0	69.18	0	0	0	146.9
	Reduction in Loadings	0.00	0.00	31.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.1
	% Reduction	0	0	28.57	0	0	0	0	0	0	0	0	0	17.5
30 – Hemlo Gold Mines, Golden Giant PR 0100	Days of Discharge	0.00	0.00	0.00	0.00	0.00	18.00	31.00	30.00	31.00	30.00	31.00	18.00	188
	Present Monthly Loadings	0	0	0	0	0	1.89	1.65	4.88	14.82	13.14	17.95	10.57	64.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	1.89	1.65	4.88	14.82	13.14	17.95	10.57	64.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	1.89	1.65	4.88	14.82	13.14	16.98	9.89	62.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	1.68	2.9
	% Reduction	0	0	0	0	0	0	0	0	0	0	5.41	17.81	4.4
31 – Cenamax, Kremzar Mine PR 0100	Days of Discharge	0.00	0.00	16.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32
	Present Monthly Loadings	0	0	1.15	1.26	0	0	0	0	0	0	0	0	2.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	1.15	1.26	0	0	0	0	0	0	0	0	2.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	1.15	1.26	0	0	0	0	0	0	0	0	2.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 – LAC Minerals, Macassa Division PR 0100	Days of Discharge	29	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings	2.99	27.45	33.39	882.51	7.47	13.48	1.74	0.54	2.12	14.41	13.8	0.84	780.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	2.99	27.45	33.39	882.51	7.47	13.48	1.74	0.54	2.12	14.41	13.8	0.84	780.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.99	17.49	27.47	587.03	7.47	13.48	1.74	0.54	2.12	14.41	13.8	0.84	889.4
	Reduction in Loadings	0.00	9.96	5.92	75.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.4
	% Reduction	0	36.27	17.72	11.39	0	0	0	0	0	0	0	0	11.7
35 – Cenamax, Marhill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	3.04	3.18	3.85	3.01	1.29	0.81	1.19	0.79	0.98	0.88	1.35	1.9	22.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	3.04	3.18	3.85	3.01	1.29	0.81	1.19	0.79	0.98	0.88	1.35	1.9	22.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.04	3.18	3.85	3.01	1.29	0.81	1.19	0.79	0.98	0.88	1.35	1.9	22.1
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
36 – American Barrick, McDermott PR 0100	Days of Discharge	0.00	11.00	27.00	19.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
	Present Monthly Loadings	0	1.83	4.01	2.62	0	0	0	0	0	0	0	0	8.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	1.83	4.01	2.62	0	0	0	0	0	0	0	0	8.5
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	1.83	4.01	2.62	0	0	0	0	0	0	0	0	8.5
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Nickel

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
37 -- Bond Gold, Muskegsagegan Lake PR 0100	Days of Discharge	28	0	0	31	30	31	31	30	0	30	31	31	273
	Present Monthly Loadings	0.03	0	0	0.48	0.52	0.15	0.19	0.07	0	0.3	0.07	0.02	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.03	0	0	0.48	0.52	0.15	0.19	0.07	0	0.3	0.07	0.02	1.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.03	0	0	0.48	0.52	0.15	0.19	0.07	0	0.3	0.07	0.02	1.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 -- LAC Minerals, Williams Mine MW 0100	Days of Discharge	28.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56
	Present Monthly Loadings	0.82	0.83	0	0	0	0	0	0	0	0	0	0	1.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.82	0.83	0	0	0	0	0	0	0	0	0	0	1.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.82	0.83	0	0	0	0	0	0	0	0	0	0	1.7
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 -- LAC Minerals, Williams Mine PR 0200	Days of Discharge	0.00	0.00	0.00	10.00	29.00	31.00	31.00	30.00	17.00	0.00	0.00	0.00	148
	Present Monthly Loadings	0	0	0	7.66	18.87	13.41	15.17	13.72	8.29	0	0	0	76.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	7.66	18.87	13.41	15.17	13.72	8.29	0	0	0	76.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	7.66	18.87	13.41	15.17	13.72	8.29	0	0	0	76.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
39 -- Giant Yellowknife, Pamour #1 PR 0100	Days of Discharge	28	31	30	31	30	31	31	15	31	30	0	21	309
	Present Monthly Loadings	58.6	52.57	26.86	28.52	4.22	5.37	3.04	0.22	1.08	1.13	0	1.47	186.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	40.8	52.57	26.86	28.52	4.22	5.37	3.04	0.22	1.08	1.13	0	1.47	167.4
	Reduction in Loadings	16.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.9
	% Reduction	31.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	9.18	22.37	15.14	28.52	4.22	5.37	3.04	0.22	1.08	1.13	0	1.47	90.7
	Reduction in Loadings	51.62	30.20	13.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	95.6
	% Reduction	88.32	57.45	47.58	0	0	0	0	0	0	0	0	0	51.3
39 -- Giant Yellowknife, Pamour #1 PR 0200	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
	Present Monthly Loadings	0	0	0	0	0	0	0	0.19	2.48	0.21	0	0	2.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0	0	0.19	2.48	0.21	0	0	2.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	0	0.19	2.48	0.21	0	0	2.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
42 -- Renebie Gold Mines PR 0100	Days of Discharge	0.00	14.00	0.00	28.00	26.00	30.00	1.00	5.00	0.00	0.00	0.00	0.00	104
	Present Monthly Loadings	0	10.77	0	8.44	3.09	3.42	0.02	0.12	0	0	0	0	23.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	10.77	0	8.44	3.09	3.42	0.02	0.12	0	0	0	0	23.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	10.77	0	8.44	3.09	3.42	0.02	0.12	0	0	0	0	23.9
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Nickel

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
45 – St. Andrews Gold Fields PR 0100	Days of Discharge	0	0	0	0	0	28	31	30	31	29	0	0	147
	Present Monthly Loadings	0	0	0	0	0	0.87	0.14	0.82	1.72	1.24	0	0	4.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0.87	0.14	0.82	1.72	1.24	0	0	4.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0.87	0.14	0.82	1.72	1.24	0	0	4.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
46 – Algoma Steel, Ore Division PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	180
	Present Monthly Loadings	5.21	6.8	8.14	5.3	3.92	5.84	0	0	0	0	0	0	33.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	5.21	6.8	8.14	5.3	3.92	5.84	0	0	0	0	0	0	33.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	5.21	6.8	8.14	5.3	3.92	5.84	0	0	0	0	0	0	33.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	66.01	92.23	74.35	50.1	13.18	18.32	24.26	28.1	21.73	29.22	28.02	7.26	450.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	66.01	92.23	74.35	50.1	13.18	18.32	24.26	28.1	21.73	29.22	28.02	7.26	450.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	66.01	92.23	74.35	50.1	13.18	18.32	24.26	28.1	21.73	29.22	28.02	7.26	450.6
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property SW 0200	Days of Discharge	28	31	30	31	30	31	23	18	31	30	31	31	343
	Present Monthly Loadings	0.04	0.05	0.21	0.07	0.07	0.12	0.04	0.02	0.08	0.12	0.27	0.07	1.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.04	0.05	0.21	0.07	0.07	0.12	0.04	0.02	0.08	0.12	0.27	0.07	1.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.04	0.05	0.21	0.07	0.07	0.12	0.04	0.02	0.08	0.12	0.27	0.07	1.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
52 – Rio Algom, Lacnor/Nordic SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings	0.58	6.85	11.74	3.56	0.43	2.05	0.08	0.28	4.99	16.04	4.89	3.33	56.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.58	6.85	11.74	3.56	0.43	2.05	0.08	0.28	4.99	16.04	4.89	3.33	56.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.58	6.85	11.74	3.56	0.43	2.05	0.08	0.28	4.99	16.04	4.89	3.33	56.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel SR 0100	Days of Discharge	28.00	31.00	30.00	30.87	29.87	31.00	31.00	30.00	22.86	21.21	29.00	25.21	336.45
	Present Monthly Loadings	27.24	38.36	28.85	13.38	8.35	19.38	12.38	11.41	18.61	13.88	24.27	18.17	235.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	27.24	38.36	28.85	13.38	8.35	19.38	12.38	11.41	18.61	13.88	24.27	18.17	235.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	27.24	38.36	28.85	13.38	8.35	19.38	12.38	11.41	18.62	13.88	17.34	18.17	228.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	0.00	6.93	0.00	8.8
	% Reduction	0	0	0	0	0	0	0	0	8.09	0	28.57	0	3.7

Nickel

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
54 – Rio Algom, Pronto SW 0100	Days of Discharge	0	12	29.67	31	28.25	0	11	0	0	0	21	0	132.92
	Present Monthly Loadings	0	3.55	5.74	1.88	2.27	0	2.99	0	0	0	3.74	0	20.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	3.55	5.74	1.88	2.27	0	2.99	0	0	0	3.74	0	20.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	3.55	5.74	1.88	2.27	0	2.99	0	0	0	3.74	0	20.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
55 – Rio Algom, Quirke PR 0100	Days of Discharge	28.00	31.00	30.00	0.00	30.00	31.00	30.00	30.00	30.50	27.70	19.42	23.92	311.54
	Present Monthly Loadings	28.14	83.53	48.93	0	138.04	32.03	22.1	5.87	50.49	40.62	31.03	25.42	484.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	28.14	83.53	48.93	0	138.04	32.03	22.1	5.87	50.49	40.62	31.03	25.42	484.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	28.14	83.53	48.93	0	95.2	32.03	22.1	5.87	50.49	40.62	31.03	25.42	441.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	42.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.8
	% Reduction	0	0	0	0	31.03	0	0	0	0	0	0	0	8.8
56 – Cameco, Refinery, Blind River SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	20.00	0.00	0.00	0.00	22.00	29.00	31.00	31.00	253
	Present Monthly Loadings	0.17	0.2	0.15	0.18	0.14	0	0	0	0.14	0.18	0.83	0.19	2.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.17	0.2	0.15	0.18	0.14	0	0	0	0.14	0.18	0.83	0.19	2.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.17	0.2	0.15	0.18	0.14	0	0	0	0.14	0.18	0.83	0.19	2.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0100	Days of Discharge	28	31	30	31	27	0	0	0	21	30	31	31	260
	Present Monthly Loadings	4.65	5.58	4.4	24.58	4.33	0	0	0	3.78	5.67	4.78	5.05	63.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	4.65	5.58	4.4	24.58	4.33	0	0	0	3.78	5.67	4.78	5.05	63.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.65	5.58	4.4	24.58	4.33	0	0	0	3.78	5.67	4.78	5.05	63.2
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0200	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings	0.48	0.61	0.65	0.64	0.52	0	0	0	0.12	0.27	0.33	0.35	4.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.48	0.61	0.65	0.64	0.52	0	0	0	0.12	0.27	0.33	0.35	4.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.48	0.61	0.65	0.64	0.52	0	0	0	0.12	0.27	0.33	0.35	4.0
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings	0.21	0.22	0.22	0.24	0.11	0	0	0	0.08	0.08	0.1	0.17	1.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.21	0.22	0.22	0.24	0.11	0	0	0	0.08	0.08	0.1	0.17	1.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.21	0.22	0.22	0.24	0.11	0	0	0	0.08	0.08	0.1	0.17	1.4
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Nickel

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
58 – Rio Algom, Stanleigh SR 0100	Days of Discharge	26	27.5	26.45	31	25.71	25.04	0	13.5	31	25.71	27.66	29.99	291.76
	Present Monthly Loadings	23.2	26.36	20.09	18.62	26.64	23.33	0	13.44	37.3	18.67	12.91	92.32	311.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	23.2	26.36	20.09	18.62	26.64	23.33	0	13.44	37.3	18.67	12.91	92.32	311.8
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	23.2	26.36	20.09	18.62	26.64	23.33	0	13.44	37.3	18.67	12.91	71.02	290.5
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.31	21.3
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	23.08	6.6
59 – Denison Mines, Stanrock SW 0100	Days of Discharge	28.00	31.00	0.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	335
	Present Monthly Loadings	0.89	0.63	0	0.42	0.02	0.56	0.63	0.07	0.42	1.71	1.69	0.29	7.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.89	0.63	0	0.42	0.02	0.56	0.63	0.07	0.42	1.71	1.69	0.29	7.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.89	0.63	0	0.42	0.02	0.56	0.63	0.07	0.42	1.71	1.69	0.29	7.3
	Reduction in Loadings	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
01 – INCO, Copper Cliff T.P.	Days of Discharge	28	31	30	31	30	30	31	30	31	30	31	31	364
PR 0100	Present Monthly Loadings, kg	49.4	59.91	54.14	57.73	49.44	41.67	32.03	37.49	67.86	44.13	188.23	47.78	739.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	49.4	59.91	54.14	57.73	49.44	41.67	32.03	37.49	67.86	44.13	188.23	47.78	739.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	49.40	59.91	54.14	57.73	49.44	41.67	32.03	37.49	67.86	44.13	188.23	47.78	739.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
02 – INCO, Crean Hill Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
MW 0100	Present Monthly Loadings, kg	0.84	1.92	1.94	1.54	0.97	0.93	0.27	0.54	1.49	2.27	1.38	0.81	14.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.84	1.92	1.94	1.54	0.97	0.93	0.27	0.54	1.49	2.27	1.38	0.81	14.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.84	1.92	1.94	1.54	0.97	0.93	0.27	0.54	1.49	2.27	1.38	0.81	14.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
03 – Falconbridge, Falconbridge	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	21.38	35.12	33.94	22.84	10.18	2.87	9.49	10.02	17.85	21.38	17.75	10.88	210.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	21.38	35.12	33.94	22.84	10.18	2.87	9.49	10.02	17.85	21.38	17.75	10.88	210.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	21.38	35.12	33.94	22.84	10.18	2.87	9.49	10.02	17.85	21.38	17.75	10.88	210.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
04 – INCO, Garson Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
MW 0100	Present Monthly Loadings, kg	0.62	1.87	1.13	1.36	0.85	1.21	0.99	0.89	1.58	1.44	1.55	1.03	14.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.62	1.87	1.13	1.36	0.85	1.21	0.99	0.89	1.58	1.44	1.55	1.03	14.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.62	1.87	1.13	1.36	0.85	1.21	0.99	0.68	1.58	1.44	1.55	1.03	14.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
05 – Noranda Minerals, Geco Division	Days of Discharge	28.00	21.15	28.25	30.29	29.90	29.87	20.19	28.04	30.57	29.17	29.99	30.04	336.46
PR 0100	Present Monthly Loadings, kg	1.44	1.07	1.88	1.86	1.85	2.18	1.59	3.79	3.88	7.4	5.62	4.59	38.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	1.44	1.07	1.88	1.86	1.85	2.18	1.59	3.79	3.88	7.4	5.62	4.59	38.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.44	1.07	1.88	1.88	1.85	2.18	1.59	3.79	3.88	7.4	5.62	4.59	38.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
06 – Falconbridge, Kidd Creek Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
MW 0100	Present Monthly Loadings, kg	0.52	1.96	2.63	3.53	5.80	1.53	0.94	1.53	3.38	3.42	0.93	1.29	27.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.52	1.96	2.63	3.53	5.8	1.53	0.94	1.53	3.38	3.42	0.93	1.29	27.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.52	1.96	2.63	3.53	5.8	1.53	0.94	1.53	3.38	3.42	0.93	1.29	27.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
07 – INCO, Levack Mine MW 0100	Days of Discharge	28.00	30.00	30.00	31.00	30.00	31.00	31.00	30.00	29.00	15.00	31.00	31.00	347
	Present Monthly Loadings, kg	1.09	1.5	1.37	0.8	0.98	1.09	0.26	0.4	0.84	1.67	1.13	1.05	12.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	1.09	1.5	1.37	0.8	0.98	1.09	0.26	0.4	0.84	1.67	1.13	1.05	12.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.09	1.5	1.37	0.8	0.98	1.09	0.26	0.4	0.84	1.67	1.13	1.05	12.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
08 – Falconbridge, Lockerby MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.47	1.39	1.29	1.05	0.88	0.76	0.65	0.62	0.84	1.3	1.08	0.8	11.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.47	1.39	1.29	1.05	0.88	0.76	0.65	0.62	0.84	1.3	1.08	0.8	11.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.47	1.39	1.29	1.05	0.88	0.76	0.65	0.62	0.84	1.3	1.08	0.8	11.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
09 – Falconbridge, Metallurgical PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	16.15	20.37	6.42	7.21	12.76	8.65	4.72	3.53	6.17	5.10	3.76	5.40	105.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	16.15	20.37	6.42	7.21	12.76	8.65	4.72	3.53	6.17	5.1	3.76	5.4	105.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	16.15	20.37	6.42	7.21	12.76	8.65	4.72	3.53	6.17	5.1	3.76	5.4	105.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	3.07	3.16	3.45	2.16	5.23	0.76	3.02	2.24	5.11	4.24	2.9	7.6	43.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	3.07	3.16	3.45	2.16	5.23	0.76	3.02	2.24	5.11	4.24	2.8	7.6	43.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.07	3.16	3.45	2.16	5.23	0.76	3.02	2.24	5.11	4.24	2.90	7.60	43.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	3.19	13.39	11.48	6.47	8.1	10.04	5.3	8.64	5.8	7.29	7.81	1.12	88.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	3.19	13.39	11.48	6.47	8.1	10.04	5.3	8.64	5.8	7.29	7.81	1.12	88.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.19	13.39	11.48	6.47	8.1	10.04	5.3	8.64	5.8	7.29	7.81	1.12	88.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
12 – Falconbridge, Onaping MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.85	1.32	1.26	0.82	0.48	0.48	0.54	0.53	0.53	0.88	0.63	0.7	8.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.85	1.32	1.26	0.82	0.48	0.48	0.54	0.53	0.53	0.88	0.63	0.7	8.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.85	1.32	1.26	0.82	0.48	0.48	0.54	0.53	0.53	0.88	0.63	0.7	8.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	*Total Year*
13 – INCO, Refinery, Port Colborne	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
SR 0100	Present Monthly Loadings, kg	3.95	4.61	6.92	5.73	4.84	3.17	3.83	4.92	7.61	4.12	6.7	5.76	62.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	3.95	4.61	6.92	5.73	4.84	3.17	3.83	4.92	7.61	4.12	6.7	5.76	62.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.95	4.61	6.92	5.73	4.84	3.17	3.83	4.92	7.61	4.12	6.70	5.76	62.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
14 – INCO, Shebandowan Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	1.3	2.66	3.05	3.91	2.96	1.67	0.94	1.57	2.43	2.32	2.21	2.41	27.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	1.3	2.66	3.05	3.91	2.96	1.67	0.94	1.57	2.43	2.32	2.21	2.41	27.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.3	2.66	3.05	3.91	2.96	1.67	0.94	1.57	2.43	2.32	2.21	2.41	27.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15 – Falconbridge, Strathcona	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	18.00	23.00	31.00	280
PR 0100	Present Monthly Loadings, kg	19.98	18.50	56.77	40.20	18.38	18.83	18.09	0.00	0.00	10.57	3.48	11.07	214.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	19.98	18.5	56.77	40.2	18.38	18.83	18.09	0	0	10.57	3.48	11.07	214.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	19.98	18.5	56.77	40.2	18.38	18.83	18.09	0	0	10.57	3.48	11.07	214.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
16 – INCO, Whistle Mine	Days of Discharge	0.00	11.00	16.00	31.00	30.00	29.00	0.00	0.00	22.00	30.00	31.00	14.00	214
MW 0100	Present Monthly Loadings, kg	0	0.14	0.04	0.19	0.12	0.27	0	0	0.8	0.32	0.45	0.02	2.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0.14	0.04	0.19	0.12	0.27	0	0	0.8	0.32	0.45	0.02	2.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.14	0.04	0.19	0.12	0.27	0	0	0.8	0.32	0.45	0.02	2.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
17 – Minnova, Winston Lake Mine	Days of Discharge	0.00	0.00	0.00	31.00	30.00	31.00	31.00	15.00	27.00	15.00	31.00	31.00	242
PR 0100	Present Monthly Loadings, kg	0	0	0	0.59	0.68	0.59	0.61	0.41	1.36	0.48	1.02	1.2	6.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	0.59	0.68	0.59	0.61	0.41	1.36	0.48	1.02	1.2	6.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0.59	0.68	0.59	0.61	0.41	1.36	0.48	1.02	1.2	6.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
19 – Dickenson, Arthur W. White Mine	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	316
PR 0100	Present Monthly Loadings, kg	8.11	10.94	5.82	0.00	56.28	72.50	54.96	68.68	36.21	12.49	6.84	4.24	337.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	8.11	10.94	5.82	0	56.28	72.5	54.96	68.68	36.21	12.49	6.84	4.24	337.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	8.11	10.94	5.82	0	56.28	72.5	54.96	68.68	36.21	12.49	6.84	4.24	337.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total/ Year
21 – Cenemax, Bell Creek Mine	Days of Discharge	0	0	0	0	0	0	31	23	31	0	0	0	85
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0	0.35	0.18	0.49	0	0	0	1.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	0	0	0	0.35	0.18	0.49	0	0	0	1.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.18	0.49	0.00	0.00	0.00	1.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24 – Teck – Corone, David Bell Mine	Days of Discharge	25.00	8.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	264
PR 0100	Present Monthly Loadings, kg	1.73	0.27	0	2.43	2.88	3.54	3.5	3.11	2.24	1.48	2.75	3.81	27.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	1.73	0.27	0	2.43	2.88	3.54	3.5	3.11	2.24	1.48	2.75	3.81	27.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.73	0.27	0	2.43	2.88	3.54	3.5	3.11	2.24	1.48	2.75	3.81	27.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
25 – Placer Dome, Detour Lake Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	4.51	6.68	19.18	114.81	30.83	8.87	0.04	0.21	80.37	41.81	13.61	7.51	328.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	4.51	6.68	19.18	114.81	30.83	8.87	0.04	0.21	80.37	41.81	13.61	7.51	328.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.51	6.68	19.18	114.81	30.83	8.87	0.04	0.21	80.37	41.81	13.61	7.51	328.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
26 – Placer Dome, Dome Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	5.00	23.00	331
PR 0100	Present Monthly Loadings, kg	10.18	21.02	48.28	31.18	13.67	18.9	23.57	15.07	21.26	15.18	2.58	10.87	230.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	10.18	21.02	48.28	31.18	13.67	18.9	23.57	15.07	21.26	15.18	2.58	10.87	230.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	10.18	21.02	48.28	31.18	13.67	18.90	23.57	15.07	21.26	15.18	2.58	10.87	230.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
27 – Placer Dome, Dona Lake Mine	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
PR 0100	Present Monthly Loadings, kg	0	0	0	7.85	3.27	6.74	0	0	3.67	5.22	0	0	26.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	7.85	3.27	6.74	0	0	3.67	5.22	0	0	26.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	7.85	3.27	6.74	0	0	3.67	5.22	0	0	26.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
29 – Eastmeque Gold Mines	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	0.51	8.27	20.82	18.80	6.53	4.88	2.23	4.55	8.90	7.20	3.30	0.68	85.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.51	8.27	20.82	18.8	5.53	4.88	2.23	4.55	8.9	7.2	3.3	0.68	85.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.51	8.27	20.82	18.8	5.53	4.68	2.23	4.55	8.9	7.2	3.3	0.68	85.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
28 – Giant Yellowknife, ERG Res.	Days of Discharge	0.00	0.00	27.00	0.00	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	40
PR 0100	Present Monthly Loadings, kg	0	0	23.33	0	0	0	0	0	30.08	0	0	0	53.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	23.33	0	0	0	0	0	30.08	0	0	0	53.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	23.33	0	0	0	0	0	30.08	0	0	0	53.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
30 – Hemlo Gold Mines, Golden Giant	Days of Discharge	0.00	0.00	0.00	0.00	0.00	18.00	31.00	30.00	31.00	30.00	31.00	18.00	188
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0.94	2.7	1.44	2.88	5.04	5.09	2.03	20.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	0	0	0.94	2.7	1.44	2.88	5.04	5.09	2.03	20.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0.94	2.7	1.44	2.88	5.04	5.09	2.03	20.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
31 – Cenemax, Kremzar Mine	Days of Discharge	0.00	0.00	16.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32
PR 0100	Present Monthly Loadings, kg	0.00	0.00	2.30	47.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	2.3	47.88	0	0	0	0	0	0	0	0	50.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	2.3	25.2	0	0	0	0	0	0	0	0	27.5
	Reduction in Loadings	0	0	0	22.684	0	0	0	0	0	0	0	0	22.7
	% Reduction	0	0	0	47.37	0	0	0	0	0	0	0	0	45.2
32 – LAC Minerals, Macasse Division	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
PR 0100	Present Monthly Loadings, kg	1.48	5.25	9.51	176.11	5.77	5.32	1.79	1.07	3.34	6.8	4.17	1.56	222.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	1.48	5.25	9.51	176.11	5.77	5.32	1.79	1.07	3.34	6.8	4.17	1.56	222.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.48	5.25	9.51	176.11	5.77	5.32	1.79	1.07	3.34	6.80	4.17	1.56	222.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
35 – Cenemax, Merhill Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
MW 0100	Present Monthly Loadings, kg	1.17	1.41	2.14	1.29	0.5	1.21	0.44	0.38	0.39	1.02	1.35	1.17	12.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	1.17	1.41	2.14	1.29	0.5	1.21	0.44	0.38	0.39	1.02	1.35	1.17	12.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.17	1.41	2.14	1.29	0.5	1.21	0.44	0.38	0.39	1.02	1.35	1.17	12.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – American Barrick, McDermott	Days of Discharge	0.00	11.00	27.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
PR 0100	Present Monthly Loadings, kg	0	2.89	12.02	6.38	0	0	0	0	0	0	0	0	21.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	2.89	12.02	6.38	0	0	0	0	0	0	0	0	21.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	2.89	12.02	6.38	0	0	0	0	0	0	0	0	21.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
37 – Bond Gold, Muskegsagagen Lake	Days of Discharge	28.00	0.00	0.00	31.00	30.00	31.00	31.00	30.00	0.00	30.00	31.00	31.00	273
PR 0100	Present Monthly Loadings, kg	0.07	0	0	0.93	1.05	0.3	0.39	0.13	0	0.8	0.13	0.04	3.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.07	0	0	0.93	1.05	0.3	0.39	0.13	0	0.8	0.13	0.04	3.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.07	0.00	0.00	0.93	1.05	0.30	0.39	0.13	0.00	0.80	0.13	0.04	3.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine	Days of Discharge	28.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56
MW 0100	Present Monthly Loadings, kg	0.83	1.11	0	0	0	0	0	0	0	0	0	0	1.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.83	1.11	0	0	0	0	0	0	0	0	0	0	1.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.83	1.11	0	0	0	0	0	0	0	0	0	0	1.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine	Days of Discharge	0.00	0.00	0.00	10.00	29.00	31.00	31.00	30.00	17.00	0.00	0.00	0.00	148
PR 0200	Present Monthly Loadings, kg	0.00	0.00	0.00	4.30	10.50	13.25	9.70	10.83	8.21	0.00	0.00	0.00	56.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	4.3	10.5	13.25	9.7	10.83	8.21	0	0	0	56.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	4.3	10.5	13.25	9.7	10.83	8.21	0	0	0	56.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
39 – Giant Yellowknife, Pamour #1	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	15.00	31.00	30.00	0.00	21.00	309
PR 0100	Present Monthly Loadings, kg	2.54	8.71	4.54	8.93	2.49	2.83	2.09	0.25	1.71	1.26	0	0.63	34.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	2.54	8.71	4.54	8.93	2.49	2.83	2.09	0.25	1.71	1.26	0	0.63	34.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.54	8.71	4.54	8.93	2.49	2.83	2.09	0.25	1.71	1.26	0	0.63	34.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
39 – Giant Yellowknife, Pamour #1	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
PR 0200	Present Monthly Loadings, kg	0	0	0	0	0	0	0	0.29	1.14	0.08	0	0	1.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	0	0	0	0	0.29	1.14	0.08	0	0	1.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	0	0.29	1.14	0.08	0	0	1.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
42 – Renable Gold Mines	Days of Discharge	0.00	14.00	0.00	28.00	28.00	30.00	1.00	5.00	0.00	0.00	0.00	0.00	104
PR 0100	Present Monthly Loadings, kg	0.00	1.47	0.00	2.48	1.42	2.70	0.00	0.10	0.00	0.00	0.00	0.00	8.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	1.47	0	2.48	1.42	2.7	0	0.1	0	0	0	0	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	1.47	0	2.48	1.42	2.7	0	0.1	0	0	0	0	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Year
45 – St. Andrews Gold Fields	Days of Discharge	0	0	0	0	0	28	31	30	31	29	0	0	147
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0.39	0.28	0.32	0.86	0.3	0	0	2.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	0	0	0	0	0.39	0.28	0.32	0.86	0.3	0	0	2.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.00	0.00	0.00	0.00	0.00	0.39	0.28	0.32	0.86	0.30	0.00	0.00	2.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
46 – Algoma Steel, Ore Division	Days of Discharge	28.00	31.00	30.00	31.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	180
PR 0100	Present Monthly Loadings, kg	0.78	1.02	0.82	0.78	0.84	0.85	0	0	0	0	0	0	5.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.78	1.02	0.82	0.78	0.84	0.85	0	0	0	0	0	0	5.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.78	1.02	0.82	0.78	0.84	0.85	0	0	0	0	0	0	5.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	8.25	10.38	10.33	10.02	9.42	7.83	7.56	8.18	9.45	9.13	8.78	8.08	107.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	8.25	10.38	10.33	10.02	9.42	7.83	7.56	8.18	9.45	9.13	8.78	8.08	107.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	8.25	10.38	10.33	10.02	9.42	7.83	7.56	8.18	9.45	9.13	8.78	8.08	107.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	23.00	18.00	31.00	30.00	31.00	31.00	343
SW 0200	Present Monthly Loadings, kg	0.05	0.05	0.21	0.08	0.08	0.13	0.04	0.03	0.09	0.13	0.29	0.08	1.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.05	0.05	0.21	0.08	0.08	0.13	0.04	0.03	0.09	0.13	0.29	0.08	1.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.05	0.05	0.21	0.08	0.08	0.13	0.04	0.03	0.09	0.13	0.29	0.08	1.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
52 – Rio Algom, Lacnor/Nordic	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
SW 0100	Present Monthly Loadings, kg	0.87	18.82	23.48	7.18	0.88	3.08	0.12	0.22	10.97	38.88	8.74	4.18	111.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.87	18.82	23.48	7.18	0.88	3.08	0.12	0.22	10.97	38.88	8.74	4.18	111.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.87	18.82	23.48	7.18	0.88	3.08	0.12	0.22	10.97	38.88	8.74	4.18	111.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel	Days of Discharge	28.00	31.00	30.00	30.87	29.87	31.00	31.00	30.00	22.86	21.21	28.00	25.21	338.45
SR 0100	Present Monthly Loadings, kg	15.13	30.89	10.82	10.02	9.35	11.83	9.29	5.31	13.20	4.85	4.33	19.17	142.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	15.13	30.89	10.82	10.02	9.35	11.83	9.29	5.31	13.2	4.85	4.33	19.17	142.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	15.13	30.89	10.82	10.02	9.35	11.83	9.29	5.31	13.2	4.85	4.33	19.17	142.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total / Year
54 – Rio Algom, Pronto SW 0100	Days of Discharge	0.00	12.00	29.67	31.00	26.25	0.00	11.00	0.00	0.00	0.00	21.00	0.00	132.92
	Present Monthly Loadings, kg	0	5.33	6.61	2.49	3.41	0	4.86	0	0	0	4.31	0	29.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0	5.33	6.61	2.49	3.41	0	4.99	0	0	0	4.31	0	29.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	5.33	6.61	2.49	3.41	0	4.99	0	0	0	4.31	0	29.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
55 – Rio Algom, Quirke PR 0100	Days of Discharge	28.00	31.00	30.00	0.00	30.00	31.00	30.00	30.00	30.50	27.70	19.42	23.92	311.54
	Present Monthly Loadings, kg	17.59	49.41	37.55	0	38.06	9.61	12.63	3.26	55.46	31.51	22.16	14.52	291.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	17.59	49.41	37.55	0	38.06	9.61	12.63	3.26	55.46	31.51	22.16	14.52	291.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	17.59	49.41	37.55	0	38.06	9.61	12.63	3.26	55.46	31.51	22.16	14.52	291.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
56 – Cameco, Refinery, Blind River SR 0300	Days of Discharge	26.00	31.00	30.00	31.00	20.00	0.00	0.00	0.00	22.00	26.00	31.00	31.00	253
	Present Monthly Loadings, kg	0.19	0.22	0.17	0.16	0.16	0.00	0.00	0.00	0.15	0.20	0.16	0.21	1.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.19	0.22	0.17	0.16	0.16	0	0	0	0.15	0.2	0.16	0.21	1.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.19	0.22	0.17	0.16	0.16	0	0	0	0.15	0.2	0.16	0.21	1.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0100	Days of Discharge	28	31	30	31	27	0	0	0	21	30	31	31	260
	Present Monthly Loadings, kg	5.39	6.16	4.69	6.62	4.61	0	0	0	4.2	6.52	5.32	5.61	49.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	5.39	6.16	4.66	6.62	4.61	0	0	0	4.2	6.52	5.32	5.61	49.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	5.39	6.16	4.66	6.62	4.61	0.00	0.00	0.00	4.20	6.52	5.32	5.61	49.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0200	Days of Discharge	26.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings, kg	0.51	0.66	0.73	0.71	0.56	0	0	0	0.14	0.3	0.38	0.38	4.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.51	0.66	0.73	0.71	0.56	0	0	0	0.14	0.3	0.38	0.38	4.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.51	0.66	0.73	0.71	0.56	0	0	0	0.14	0.3	0.38	0.38	4.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings, kg	0.23	0.25	0.24	0.27	0.12	0	0	0	0.07	0.16	0.11	0.19	1.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.23	0.25	0.24	0.27	0.12	0	0	0	0.07	0.16	0.11	0.19	1.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.23	0.25	0.24	0.27	0.12	0	0	0	0.07	0.16	0.11	0.19	1.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Lead

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total / Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
58 – Rio Algom, Stanleigh SR 0100	Days of Discharge	28.00	27.50	28.45	31.00	25.71	25.04	0.00	13.50	31.00	25.71	27.68	29.99	291.76
	Present Monthly Loadings, kg	17.4	29.38	18.07	18.62	21.55	14	0	3.84	38.3	40.58	58.09	78.12	333.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	17.4	29.38	18.07	18.62	21.55	14	0	3.84	38.3	40.58	58.09	78.12	333.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	17.40	29.38	18.07	18.62	21.55	14.00	0.00	3.84	38.30	38.89	58.09	71.02	322.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	3.6888	0	7.1017	10.8
	% Reduction	0	0	0	0	0	0	0	0	0	9.09	0	9.08	3.2
59 – Denison Mines, Stanrock SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.86	0.7	1.88	0.47	0.03	0.43	0.32	0.08	0.47	1.22	1.87	0.32	8.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.2 mg/L	0.86	0.7	1.88	0.47	0.03	0.43	0.32	0.08	0.47	1.22	1.87	0.32	8.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.89	0.7	1.88	0.47	0.03	0.43	0.32	0.08	0.47	1.22	1.87	0.32	8.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Zinc

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total Year
01 – INCO, Copper Cliff T.P. PR 0100	Days of Discharge	28	31	30	31	30	30	31	30	31	30	31	31	364
	Present Monthly Loadings, kg	28.73	28.98	19.84	33.82	50.78	14.54	14.13	15.41	23.41	79.71	22.12	28.39	355.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	28.73	28.98	19.84	33.82	50.78	14.54	14.13	15.41	23.41	79.71	22.12	28.39	355.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	28.73	28.98	19.84	33.82	50.78	14.54	14.13	15.41	23.41	79.71	22.12	28.39	355.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
02 – INCO, Crean Hill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.4	2.08	1.02	0.75	1.42	0.4	0.11	0.21	0.45	1.13	0.57	0.33	8.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.4	2.08	1.02	0.75	1.42	0.4	0.11	0.21	0.45	1.13	0.57	0.33	8.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.4	2.08	1.02	0.75	1.42	0.4	0.11	0.21	0.45	1.13	0.57	0.33	8.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
03 – Falconbridge, Falconbridge PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	10.95	13.88	18.88	32.47	2.03	4.84	2.35	3.8	7	43.2	28.62	7.11	172.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	10.95	13.88	18.88	32.47	2.03	4.84	2.35	3.8	7	43.2	28.62	7.11	172.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	10.95	13.88	18.88	32.47	2.03	4.84	2.35	3.8	7	43.2	28.62	7.11	172.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
04 – INCO, Garson Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.32	1.63	0.84	1.18	0.38	0.47	0.4	0.38	0.78	1.42	1.43	0.54	9.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.32	1.63	0.84	1.18	0.38	0.47	0.4	0.38	0.78	1.42	1.43	0.54	9.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.32	1.63	0.84	1.18	0.38	0.47	0.40	0.38	0.78	1.42	1.43	0.54	9.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
05 – Noranda Minerals, Geco Division PR 0100	Days of Discharge	28.00	21.15	29.25	30.29	28.90	29.87	20.19	28.04	30.57	29.17	29.99	30.04	336.46
	Present Monthly Loadings, kg	4.38	2.7	8.88	11.7	8.57	8.23	4.91	11.03	11.42	12.44	20.83	18.8	121.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	4.38	2.7	8.88	11.7	8.57	8.23	4.91	11.03	11.42	12.44	20.83	18.8	121.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.38	2.7	8.88	11.7	8.57	8.23	4.91	11.03	11.42	12.44	18.75	15.29	118.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	2.1872	3.313	5.5
	% Reduction	0	0	0	0	0	0	0	0	0	0	10.45	17.81	4.5
06 – Falconbridge, Kidd Creek Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	113.10	1966.89	837.46	812.06	421.01	381.81	119.56	221.73	1548.07	2602.74	132.07	77.84	9144.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	85.99	330.63	407.42	293.78	278.25	210.03	119.56	221.73	431.31	308	132.07	77.84	2894.7
	Reduction in Loadings	27.1074	1635.792	230.0373	518.2817	144.755	191.8817	0	0	1116.757	2294.737	0	0	6249.3
	% Reduction	23.97	83.17	38.09	87.79	34.38	48.41	0.00	0.00	72.14	88.17	0.00	0.00	68.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	17.2	88.18	81.46	58.78	55.25	42.01	28.09	51.05	88.26	81.8	31.04	23.82	600.8
	Reduction in Loadings	95.9013	1900.502	555.9758	853.306	365.755	349.9018	93.4742	170.9771	1481.807	2541.137	101.0311	53.7228	8543.2
	% Reduction	84.78	96.63	87.22	93.56	89.88	89.28	78.18	78.98	84.43	97.83	76.5	68.19	93.4

Zinc

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total/ Year
07 – INCO, Levack Mine MW 0100	Days of Discharge	28.00	30.00	30.00	31.00	30.00	31.00	31.00	30.00	28.00	15.00	31.00	31.00	347
	Present Monthly Loadings, kg	0.44	0.87	0.83	0.77	0.8	0.87	0.12	0.17	0.28	2.74	0.52	0.43	8.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.44	0.87	0.83	0.77	0.8	0.87	0.12	0.17	0.28	2.74	0.52	0.43	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.44	0.87	0.83	0.77	0.8	0.87	0.12	0.17	0.28	2.74	0.52	0.43	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
08 – Falconbridge, Lockerby MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.25	0.56	1.56	1.38	0.18	1	0.45	0.78	0.53	0.66	0.27	0.52	8.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.25	0.56	1.56	1.38	0.18	1	0.45	0.78	0.53	0.66	0.27	0.52	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.25	0.56	1.56	1.38	0.18	1	0.45	0.78	0.53	0.66	0.27	0.52	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
09 – Falconbridge, Metallurgical PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	888.11	3189.19	2191.66	516.67	1883.43	2414.37	284.59	297.29	319.27	602.69	400.40	2882.48	15628.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	501.65	1455.33	1335	516.67	681.23	853.22	284.59	297.29	319.27	680.13	400.4	568.11	7851.1
	Reduction in Loadings	384.2598	1733.859	856.6594	0	1002.2	1561.148	0	0	0	122.7828	0	2118.372	7777.3
	% Reduction	43.38	54.37	39.09	0.00	60.25	64.68	0.00	0.00	0.00	15.29	0.00	76.90	49.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	100.37	281.07	267	131.08	132.25	170.84	85.2	117.7	192.72	136.03	108.67	113.22	1845.9
	Reduction in Loadings	785.7387	2898.123	1924.659	385.6078	1531.182	2243.724	179.3838	179.5908	126.5507	466.6828	291.7288	2569.258	13782.4
	% Reduction	88.67	90.87	87.82	74.63	92.05	92.93	67.8	60.41	39.64	83.06	72.86	95.78	88.2
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	0.75	0.75	0.62	1.18	1.02	0.5	1.22	0.61	1.51	1.19	0.93	1.13	11.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.75	0.75	0.62	1.18	1.02	0.5	1.22	0.61	1.51	1.19	0.93	1.13	11.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.75	0.75	0.62	1.18	1.02	0.50	1.22	0.61	1.51	1.19	0.93	1.13	11.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	1.18	17.86	4.59	47.47	18.36	89.84	7.42	3.48	71.19	13.81	109.37	0.74	384.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.18	17.86	4.59	47.47	18.36	89.84	7.42	3.48	71.19	13.81	109.37	0.74	384.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.18	17.86	4.59	43.15	18.36	89.86	7.42	3.48	38.89	13.81	52.08	0.74	266.1
	Reduction in Loadings	0	0	0	4.3152	0	2.6784	0	0	32.4979	0	57.288	0	96.8
	% Reduction	0	0	0	9.09	0	3.85	0	0	45.65	0	52.38	0	26.5
12 – Falconbridge, Onaping MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.35	0.48	1.02	1.15	0.68	4.48	0.37	0.36	0.22	2.49	0.17	0.18	11.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.35	0.48	1.02	1.15	0.68	4.48	0.37	0.36	0.22	2.49	0.17	0.18	11.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.35	0.48	1.02	1.15	0.68	2.45	0.37	0.36	0.22	2.49	0.17	0.18	8.9
	Reduction in Loadings	0	0	0	0	0	2.0419	0	0	0	0	0	0	2.0
	% Reduction	0	0	0	0	0	45.44	0	0	0	0	0	0	17.1

Zinc

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total/ Year
13 – INCO, Refinery, Port Colborne SR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	4.1	2.47	3.08	4.58	2.52	1.98	2.21	2	2.68	1.78	2.85	2.55	32.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	4.1	2.47	3.08	4.58	2.52	1.98	2.21	2	2.68	1.78	2.85	2.55	32.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.10	2.47	3.08	4.58	2.52	1.98	2.21	2.00	2.68	1.78	2.85	2.55	32.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
14 – INCO, Shebandowan Mine PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	1.2	1.04	1.16	2.28	1.58	0.73	0.38	0.52	0.85	0.78	0.88	0.98	12.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.2	1.04	1.16	2.28	1.58	0.73	0.38	0.52	0.85	0.78	0.88	0.98	12.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.2	1.04	1.16	2.28	1.58	0.73	0.38	0.52	0.85	0.78	0.88	0.98	12.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15 – Falconbridge, Strathcona PR 0100	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	18.00	23.00	31.00	280
	Present Monthly Loadings, kg	15.68	20.83	309.07	21.78	7.50	28.88	11.69	0.00	0.00	4.71	1.07	7.98	429.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	15.68	20.83	309.07	21.78	7.5	28.88	11.88	0	0	4.71	1.07	7.98	429.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	15.68	20.63	189.23	21.78	7.5	28.88	11.69	0	0	4.71	1.07	7.98	309.3
	Reduction in Loadings	0	0	119.8442	0	0	0	0	0	0	0	0	0	119.8
	% Reduction	0	0	38.78	0	0	0	0	0	0	0	0	0	27.9
16 – INCO, Whistle Mine MW 0100	Days of Discharge	0.00	11.00	16.00	31.00	30.00	29.00	0.00	0.00	22.00	30.00	31.00	14.00	214
	Present Monthly Loadings, kg	0	1.73	0.28	0.23	0.13	0.15	0	0	8.28	1.8	0.78	0.05	11.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	1.73	0.28	0.23	0.13	0.15	0	0	8.28	1.8	0.78	0.05	11.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.73	0.28	0.23	0.13	0.15	0	0	2.88	1.8	0.78	0.05	6.8
	Reduction in Loadings	0	1.0048	0	0	0	0	0	0	3.5906	0	0	0	4.6
	% Reduction	0	57.98	0	0	0	0	0	0	57.13	0	0	0	39.6
17 – Minnove, Winston Lake Mine PR 0100	Days of Discharge	0.00	0.00	0.00	31.00	30.00	31.00	31.00	15.00	27.00	15.00	31.00	31.00	242
	Present Monthly Loadings, kg	0	0	0	30.46	21.23	17.88	14.44	12.23	78.47	11.8	9.78	8.12	203.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	25.52	21.23	17.99	14.44	11.39	35.09	11.8	9.78	8.12	153.4
	Reduction in Loadings	0	0	0	4.9483	0	0	0	0.8384	44.3827	0	0	0	50.2
	% Reduction	0.00	0.00	0.00	16.24	0.00	0.00	0.00	6.86	55.85	0.00	0.00	0.00	24.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	5.1	8.77	5.92	3.78	2.28	7.02	2.93	3.41	4	41.2
	Reduction in Loadings	0	0	0	25.3585	14.4642	12.068	10.6758	9.9512	72.4532	8.9702	8.3498	2.118	162.4
	% Reduction	0	0	0	83.25	68.12	67.1	73.94	81.37	91.17	75.37	85.05	34.58	79.8
19 – Dickenson, Arthur W. White Mine PR 0100	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	318
	Present Monthly Loadings, kg	15.85	43.77	28.12	0.00	420.12	298.64	202.76	200.35	140.82	47.80	23.58	18.80	1438.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	15.85	43.77	28.12	0	420.12	298.64	202.76	200.35	140.82	47.8	23.58	18.8	1438.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	15.85	36.47	18.91	0	180.91	241.88	202.76	200.35	137.18	40.51	18.93	14.15	1105.7
	Reduction in Loadings	0	7.2944	9.2063	0	239.2055	56.9663	0	0	3.6578	7.0895	4.6583	4.6492	332.7
	% Reduction	0	16.87	35.25	0	56.94	19.08	0	0	2.6	14.69	19.75	24.73	23.1

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Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total Year
21 – Canamax, Bell Creek Mine	Days of Discharge	0	0	0	0	0	0	31	23	31	0	0	0	85
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0	7.38	5.14	38.54	0	0	0	52.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0	7.38	5.14	22.46	0	0	0	35.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	17.0728	0	0	0	17.1
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.19	0.00	0.00	0.00	32.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.00	0.00	0.00	0.00	0.00	0.00	3.52	1.66	4.46	0.00	0.00	0.00	9.7
	Reduction in Loadings	0	0	0	0	0	0	3.8687	3.4851	35.0437	0	0	0	42.4
	% Reduction	0	0	0	0	0	0	52.38	67.74	88.84	0	0	0	81.4
24 – Teck – Corona, David Bell Mine	Days of Discharge	25.00	6.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	264
PR 0100	Present Monthly Loadings, kg	0.48	0.07	0	0.52	0.51	0.69	0.46	0.5	0.31	0.43	0.54	0.82	5.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.48	0.07	0	0.52	0.51	0.69	0.46	0.5	0.31	0.43	0.54	0.82	5.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.48	0.07	0	0.52	0.51	0.69	0.46	0.5	0.31	0.43	0.54	0.82	5.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
25 – Placer Dome, Detour Lake Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	1.88	2.73	6.39	41.04	10.21	5.4	0.03	0.09	28.79	13.94	4.54	2.88	115.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.88	2.73	6.39	41.04	10.21	5.4	0.03	0.09	28.79	13.94	4.54	2.88	115.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.88	2.73	6.39	41.04	10.21	5.4	0.03	0.09	28.79	13.94	4.54	2.88	115.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
26 – Placer Dome, Dome Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	5.00	23.00	331
PR 0100	Present Monthly Loadings, kg	6.56	30.88	16.08	10.39	5.82	5.83	7.88	5.02	6.25	14.77	1.15	5.13	115.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	6.56	30.88	16.08	10.39	5.82	5.83	7.88	5.02	6.25	14.77	1.15	5.13	115.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	6.56	30.88	16.08	10.39	5.82	5.83	7.88	5.02	6.25	14.77	1.15	5.13	115.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
27 – Placer Dome, Dona Lake Mine	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
PR 0100	Present Monthly Loadings, kg	0	0	0	2.62	6.55	0.67	0	0	5.71	0.57	0	0	16.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	2.62	6.55	0.67	0	0	5.71	0.57	0	0	16.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	2.62	6.55	0.67	0	0	5.71	0.57	0	0	16.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28 – Eastmeque Gold Mines	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	0.24	2.78	9.61	6.75	1.84	3.19	1.12	2.27	4.56	3.8	1.65	0.34	36.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.24	2.78	9.61	6.75	1.84	3.19	1.12	2.27	4.56	3.8	1.65	0.34	36.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.24	2.78	9.61	6.75	1.84	3.19	1.12	2.27	4.56	3.8	1.65	0.34	36.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

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		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
29 – Giant Yellowknife, ERG Res. PR 0100	Days of Discharge	0.00	0.00	27.00	0.00	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	40
	Present Monthly Loadings, kg	0	0	82.21	0	0	0	0	0	42.11	0	0	0	104.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	82.21	0	0	0	0	0	42.11	0	0	0	104.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	82.21	0	0	0	0	0	42.11	0	0	0	104.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
30 – Hemlo Gold Mines, Golden Giant PR 0100	Days of Discharge	0.00	0.00	0.00	0.00	0.00	18.00	31.00	30.00	31.00	30.00	31.00	18.00	188
	Present Monthly Loadings, kg	0	0	0	0	0	0.47	1.04	5.44	3.76	1.84	2.78	2.17	17.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0.47	1.04	5.44	3.76	1.84	2.78	2.17	17.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0.47	1.04	5.44	3.76	1.84	2.78	2.17	17.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
31 – Canamax, Kremzar Mine PR 0100	Days of Discharge	0.00	0.00	16.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32
	Present Monthly Loadings, kg	0.00	0.00	1.15	2.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	1.15	2.02	0	0	0	0	0	0	0	0	3.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	1.15	2.02	0	0	0	0	0	0	0	0	3.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 – LAC Minerals, Mecassa Division PR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	1.28	6.86	4.44	67.09	2.04	2.84	1.07	0.51	2.22	3.27	2.22	0.82	94.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.28	6.86	4.44	67.09	2.04	2.84	1.07	0.51	2.22	3.27	2.22	0.82	94.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.28	6.86	4.44	67.09	2.04	2.84	1.07	0.51	2.22	3.27	2.22	0.82	94.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
35 – Canamax, Merhill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	1.67	1.41	2.14	1.28	1.14	0.4	0.48	1.21	0.48	0.34	0.67	0.83	12.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.67	1.41	2.14	1.28	1.14	0.4	0.48	1.21	0.48	0.34	0.67	0.83	12.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.67	1.41	2.14	1.28	1.14	0.4	0.48	1.21	0.48	0.34	0.67	0.83	12.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
36 – American Barrick, McDermott PR 0100	Days of Discharge	0.00	11.00	27.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
	Present Monthly Loadings, kg	0	8.58	12.62	7.18	0	0	0	0	0	0	0	0	28.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	8.58	12.62	7.18	0	0	0	0	0	0	0	0	28.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	8.58	12.62	7.18	0	0	0	0	0	0	0	0	28.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

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		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Year
37 – Bond Gold, Muskegsagagen Lake PR 0100	Days of Discharge	28.00	0.00	0.00	31.00	30.00	31.00	31.00	30.00	0.00	30.00	31.00	31.00	273
	Present Monthly Loadings, kg	0.03	0	0	0.46	1.05	0.15	0.19	0.07	0	0.51	0.07	0.02	2.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.03	0	0	0.46	1.05	0.15	0.19	0.07	0	0.51	0.07	0.02	2.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.03	0.00	0.00	0.46	1.05	0.15	0.19	0.07	0.00	0.51	0.07	0.02	2.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine MW 0100	Days of Discharge	28.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56
	Present Monthly Loadings, kg	0.82	0.35	0	0	0	0	0	0	0	0	0	0	1.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.82	0.35	0	0	0	0	0	0	0	0	0	0	1.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.82	0.35	0	0	0	0	0	0	0	0	0	0	1.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine PR 0200	Days of Discharge	0.00	0.00	0.00	10.00	29.00	31.00	31.00	30.00	17.00	0.00	0.00	0.00	148
	Present Monthly Loadings, kg	0.00	0.00	0.00	0.89	4.28	4.01	3.36	4.41	1.52	0.00	0.00	0.00	18.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0.89	4.28	4.01	3.36	4.41	1.52	0	0	0	18.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0.89	4.28	4.01	3.36	4.41	1.52	0	0	0	18.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
39 – Giant Yellowknife, Pamour #1 PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	15.00	31.00	30.00	0.00	21.00	309
	Present Monthly Loadings, kg	4.91	3.36	33.54	83.62	4.75	1.49	1.08	0.13	1.09	0.85	0	0.32	135.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	4.91	3.36	33.54	83.62	4.75	1.49	1.08	0.13	1.09	0.85	0	0.32	135.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.91	3.36	15.14	29.76	4.75	1.49	1.08	0.13	1.09	0.85	0	0.32	62.7
	Reduction in Loadings	0	0	18.3991	54.0587	0	0	0	0	0	0	0	0	72.5
	% Reduction	0	0	54.88	64.5	0	0	0	0	0	0	0	0	53.6
39 – Giant Yellowknife, Pamour #1 PR 0200	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
	Present Monthly Loadings, kg	0	0	0	0	0	0	0	0.15	0.71	0.04	0	0	0.9
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0	0	0.15	0.71	0.04	0	0	0.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	0	0.15	0.71	0.04	0	0	0.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
42 – Renebie Gold Mines PR 0100	Days of Discharge	0.00	14.00	0.00	28.00	28.00	30.00	1.00	5.00	0.00	0.00	0.00	0.00	104
	Present Monthly Loadings, kg	0.00	1184.99	0.00	798.80	178.06	203.14	1.13	7.26	0.00	0.00	0.00	0.00	2382.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	244.87	0	123.92	64.41	69.68	0.8	8.06	0	0	0	0	529.9
	Reduction in Loadings	0	950.1111	0	672.8847	114.6461	133.2535	0.3357	1.2005	0	0	0	0	1852.4
	% Reduction	0.00	79.51	0.00	84.45	64.03	65.75	29.58	16.53	0.00	0.00	0.00	0.00	77.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	48.97	0	24.78	12.88	17.98	0.16	1.21	0	0	0	0	106.0
	Reduction in Loadings	0	1148.01	0	772.0208	166.1787	185.1805	0.9751	6.0512	0	0	0	0	2279.4
	% Reduction	0	95.8	0	96.89	92.81	91.15	85.92	83.31	0	0	0	0	95.8

Zinc

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total/ Year
45 – St. Andrews Gold Fields	Days of Discharge	0	0	0	0	0	26	31	30	31	29	0	0	147
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0.43	0.62	0.26	0.33	0.15	0	0	1.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0.43	0.62	0.26	0.33	0.15	0	0	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.00	0.00	0.00	0.00	0.00	0.43	0.62	0.26	0.33	0.15	0.00	0.00	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
48 – Algoma Steel, Ore Division	Days of Discharge	28.00	31.00	30.00	31.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	180
PR 0100	Present Monthly Loadings, kg	1.3	1.7	1.53	1.32	6.73	3.66	0	0	0	0	0	0	16.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.3	1.7	1.53	1.32	6.73	3.66	0	0	0	0	0	0	16.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.3	1.7	1.53	1.32	6.73	3.66	0	0	0	0	0	0	16.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	79.21	134.72	17.55	38.07	16.01	6.39	16.21	7.34	24.56	38.35	43.76	3.24	429.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	79.21	134.72	17.55	38.07	16.01	6.39	16.21	7.34	24.56	38.35	43.76	3.24	429.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	79.21	103.63	17.55	38.07	16.01	6.39	16.21	7.34	24.56	38.35	43.76	3.24	398.3
	Reduction in Loadings	0	31.0898	0	0	0	0	0	0	0	0	0	0	31.1
	% Reduction	0	23.08	0	0	0	0	0	0	0	0	0	0	7.2
51 – Denison Mines, Denison Property	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	23.00	16.00	31.00	30.00	31.00	31.00	343
SW 0200	Present Monthly Loadings, kg	0.02	0.04	0.23	0.03	0.03	0.05	0.02	0.01	0.04	0.05	0.12	0.03	0.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.02	0.04	0.23	0.03	0.03	0.05	0.02	0.01	0.04	0.05	0.12	0.03	0.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.02	0.04	0.23	0.03	0.03	0.05	0.02	0.01	0.04	0.05	0.12	0.03	0.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
52 – Rio Algom, Lacnor/Nordic	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
SW 0100	Present Monthly Loadings, kg	0.29	3.32	5.67	1.78	0.22	1.03	0.04	0.85	4.89	2.41	1.66	0.63	23.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.29	3.32	5.67	1.78	0.22	1.03	0.04	0.85	4.89	2.41	1.66	0.63	23.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.29	3.32	5.67	1.78	0.22	1.03	0.04	0.85	4.89	2.41	1.66	0.63	23.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel	Days of Discharge	28.00	31.00	30.00	30.87	29.67	31.00	31.00	30.00	22.89	21.21	28.00	25.21	338.45
SR 0100	Present Monthly Loadings, kg	6.08	15.34	32.45	6.88	6.23	3.88	3.10	6.63	29.27	5.54	4.65	20.18	143.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	6.08	15.34	32.45	6.88	6.23	3.88	3.1	6.63	29.27	5.54	4.65	20.18	143.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	6.08	15.34	32.45	6.88	6.23	3.88	3.1	6.63	18.92	5.54	4.65	20.18	130.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	12.3514	0	0	0	12.4
	% Reduction	0	0	0	0	0	0	0	0	42.2	0	0	0	8.6

Zinc

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total/ Year
54 – Rio Algom, Pronto SW 0100	Days of Discharge	0.00	12.00	29.67	31.00	26.25	0.00	11.00	0.00	0.00	0.00	21.00	0.00	132.92
	Present Monthly Loadings, kg	0	1.76	2.67	0.83	1.14	0	1	0	0	0	3.16	0	10.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	1.76	2.67	0.83	1.14	0	1	0	0	0	3.16	0	10.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	1.76	2.67	0.83	1.14	0	1	0	0	0	3.16	0	10.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
55 – Rio Algom, Quirke PR 0100	Days of Discharge	28.00	31.00	30.00	0.00	30.00	31.00	30.00	30.00	30.50	27.70	19.42	23.62	311.54
	Present Monthly Loadings, kg	7.04	14.12	8.38	0	19.04	8.61	6.31	12.8	52.62	48.82	26.6	29.05	233.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	7.04	14.12	8.38	0	19.04	8.61	6.31	12.8	52.62	48.82	26.6	29.05	233.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	7.04	14.12	8.38	0	19.04	8.61	6.31	12.8	52.62	48.82	26.6	29.05	233.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
56 – Cameco, Refinery, Blind River SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	20.00	0.00	0.00	0.00	22.00	29.00	31.00	31.00	253
	Present Monthly Loadings, kg	0.25	1.26	0.22	0.37	0.84	0.00	0.00	0.00	0.68	0.26	0.49	0.11	4.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.25	1.26	0.22	0.37	0.84	0	0	0	0.68	0.26	0.49	0.11	4.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.25	1.26	0.22	0.37	0.84	0	0	0	0.68	0.26	0.49	0.11	4.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0100	Days of Discharge	28	31	30	31	27	0	0	0	21	30	31	31	260
	Present Monthly Loadings, kg	10.24	3.09	15.63	6.14	7.69	0	0	0	2.94	2.61	6.38	4.49	59.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	10.24	3.09	15.63	6.14	7.69	0	0	0	2.94	2.61	6.38	4.49	59.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	10.24	3.09	15.63	6.14	7.69	0.00	0.00	0.00	2.94	2.61	6.38	4.49	59.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0200	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings, kg	0.97	0.27	1.31	0.5	0.76	0	0	0	0.15	0.12	0.22	0.31	4.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.97	0.27	1.31	0.5	0.76	0	0	0	0.15	0.12	0.22	0.31	4.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.97	0.27	1.31	0.5	0.76	0	0	0	0.15	0.12	0.22	0.31	4.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings, kg	0.16	0.27	0.44	0.14	0.15	0	0	0	0.12	0.26	0.85	0.17	2.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.16	0.27	0.44	0.14	0.15	0	0	0	0.12	0.26	0.85	0.17	2.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.16	0.27	0.44	0.14	0.15	0	0	0	0.12	0.26	0.85	0.17	2.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Zinc

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total / Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
58 – Rio Algom, Stanleigh SR 0100	Days of Discharge	28.00	27.50	26.45	31.00	25.71	25.04	0.00	13.50	31.00	25.71	27.86	29.99	291.76
	Present Monthly Loadings, kg	11.8	10.55	8.03	12.61	10.78	14	0	4.84	16.41	7.38	38.79	49.71	182.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	11.8	10.55	8.03	12.61	10.78	14	0	4.84	16.41	7.38	38.79	49.71	182.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	11.80	10.55	8.03	12.61	10.78	14.00	0.00	4.84	16.41	7.38	38.79	49.71	182.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
59 – Denison Mines, Stanrock SW 0100	Days of Discharge	0.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	337
	Present Monthly Loadings, kg	0	0.56	1.58	0.47	0.01	0.6	0.13	0.36	1.08	1.34	0.75	0.13	7.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0.56	1.58	0.47	0.01	0.6	0.13	0.36	1.08	1.34	0.75	0.13	7.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.56	1.58	0.47	0.01	0.6	0.13	0.36	1.08	1.34	0.75	0.13	7.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
01 – INCO, Copper Cliff T.P. PR 0100	Days of Discharge	28	31	30	31	30	30	31	30	31	30	31	31	364
	Present Monthly Loadings, kg	9.48	5.34	4.58	8.76	4.49	3.23	3.91	3.5	5.9	4.67	4.78	3.91	60.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	9.48	5.34	4.58	8.76	4.49	3.23	3.91	3.5	5.9	4.67	4.78	3.91	60.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	9.48	5.34	4.58	8.76	4.49	3.23	3.91	3.50	5.90	4.67	4.78	3.91	60.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
02 – INCO, Crean Hill Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.07	0.17	0.17	0.15	0.09	0.09	0.02	0.05	0.1	0.21	0.13	0.07	1.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.07	0.17	0.17	0.15	0.09	0.09	0.02	0.05	0.1	0.21	0.13	0.07	1.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.07	0.17	0.17	0.15	0.09	0.09	0.02	0.05	0.1	0.21	0.13	0.07	1.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
03 – Falconbridge, Falconbridge PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	3.56	5.65	5.68	3.16	6.02	2.14	2.04	1.54	1.51	1.8	2.71	0.98	36.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	3.56	5.85	5.66	3.16	6.02	2.14	2.04	1.54	1.51	1.8	2.71	0.98	36.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.56	5.65	5.66	3.16	6.02	2.14	2.04	1.54	1.51	1.8	2.71	0.96	36.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
04 – INCO, Garson Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.11	0.15	0.11	0.13	0.18	0.12	0.09	0.06	0.14	0.13	0.14	0.1	1.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.11	0.15	0.11	0.13	0.18	0.12	0.09	0.06	0.14	0.13	0.14	0.1	1.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.11	0.15	0.11	0.13	0.18	0.12	0.09	0.06	0.14	0.13	0.14	0.10	1.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
05 – Noranda Minerals, Geco Division PR 0100	Days of Discharge	28.00	21.15	29.25	30.29	29.90	29.87	20.19	28.04	30.57	29.17	29.86	30.04	336.46
	Present Monthly Loadings, kg	0.72	0.54	0.84	0.93	0.83	0.86	0.28	0.33	0.44	0.4	0.37	0.31	7.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.72	0.54	0.84	0.93	0.83	0.86	0.28	0.33	0.44	0.4	0.37	0.31	7.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.72	0.54	0.84	0.93	0.83	0.86	0.28	0.33	0.44	0.4	0.37	0.31	7.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
06 – Falconbridge, Kidd Creek Mine MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.34	1.38	2.13	1.34	1.15	0.87	0.62	1.23	2.01	1.23	1.24	0.58	14.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.34	1.38	2.13	1.34	1.15	0.87	0.62	1.23	2.01	1.23	1.24	0.58	14.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.34	1.38	2.13	1.34	1.15	0.87	0.62	1.23	2.01	1.23	1.24	0.58	14.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
07 – INCO, Levack Mine MW 0100	Days of Discharge	28.00	30.00	30.00	31.00	30.00	31.00	31.00	30.00	29.00	15.00	31.00	31.00	347
	Present Monthly Loadings, kg	0.22	0.14	0.13	0.07	0.09	0.09	0.02	0.04	0.06	0.16	0.11	0.1	1.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.22	0.14	0.13	0.07	0.09	0.09	0.02	0.04	0.06	0.16	0.11	0.1	1.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.22	0.14	0.13	0.07	0.09	0.09	0.02	0.04	0.06	0.16	0.11	0.1	1.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
08 – Falconbridge, Lockerby MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.08	0.23	0.22	0.14	0.06	0.06	0.05	0.05	0.09	0.13	0.08	0.07	1.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.08	0.23	0.22	0.14	0.06	0.06	0.05	0.05	0.09	0.13	0.08	0.07	1.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.08	0.23	0.22	0.14	0.06	0.06	0.05	0.05	0.09	0.13	0.08	0.07	1.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
09 – Falconbridge, Metallurgical PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	110.17	163.87	24.44	4.03	3.20	3.41	1.90	3.24	4.24	2.72	2.67	6.10	329.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	110.17	163.87	24.44	4.03	3.2	3.41	1.9	3.24	4.24	2.72	2.67	6.1	329.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	110.17	163.87	24.44	4.03	3.2	3.41	1.9	3.24	4.24	2.72	2.67	6.1	329.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	0.52	0.38	0.35	0.45	0.4	0.21	0.84	0.33	0.42	0.85	1.24	2.78	8.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.52	0.38	0.35	0.45	0.4	0.21	0.84	0.33	0.42	0.85	1.24	2.78	8.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.52	0.38	0.35	0.45	0.40	0.21	0.84	0.33	0.42	0.85	1.24	2.78	8.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.22	1.25	1.07	0.88	0.78	0.94	0.49	0.81	0.54	0.88	0.73	0.1	8.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.22	1.25	1.07	0.88	0.78	0.94	0.49	0.81	0.54	0.88	0.73	0.1	8.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.22	1.25	1.07	0.88	0.78	0.94	0.49	0.81	0.54	0.88	0.73	0.1	8.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
12 – Falconbridge, Onaping MW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.14	0.22	0.21	0.11	0.06	0.04	0.04	0.04	0.04	0.07	0.07	0.05	1.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.14	0.22	0.21	0.11	0.06	0.04	0.04	0.04	0.04	0.07	0.07	0.05	1.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.14	0.22	0.21	0.11	0.06	0.04	0.04	0.04	0.04	0.07	0.07	0.05	1.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total Year
13 – INCO, Refinery, Port Colborne SR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	37.38	41.85	72.24	58.54	32.87	8.77	18.93	24.28	25.84	33.18	24.48	27.22	403.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	37.38	41.85	72.24	58.54	32.87	8.77	18.93	24.28	25.84	33.18	24.49	27.22	403.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	37.38	41.85	72.24	58.54	32.87	8.77	18.93	24.28	25.84	33.18	24.48	27.22	403.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
14 – INCO, Shebandowen Mine PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0	0	0	0.38	0.28	0.17	0.09	0.12	0.18	0.18	0.2	0.22	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0.38	0.28	0.17	0.09	0.12	0.18	0.18	0.2	0.22	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0.38	0.28	0.17	0.09	0.12	0.18	0.18	0.2	0.22	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15 – Falconbridge, Strathcona PR 0100	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	18.00	23.00	31.00	260
	Present Monthly Loadings, kg	3.33	2.75	8.48	5.42	1.81	1.42	1.38	0.00	0.00	0.95	0.28	0.82	27.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	3.33	2.75	8.48	5.42	1.81	1.42	1.38	0	0	0.95	0.28	0.82	27.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	3.33	2.75	8.48	5.42	1.81	1.42	1.38	0	0	0.95	0.28	0.82	27.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
16 – INCO, Whistle Mine MW 0100	Days of Discharge	0.00	11.00	18.00	31.00	30.00	29.00	0.00	0.00	22.00	30.00	31.00	14.00	214
	Present Monthly Loadings, kg	0	0.01	0	0.02	0.01	0.02	0	0	0.04	0.03	0.03	0	0.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0.01	0	0.02	0.01	0.02	0	0	0.04	0.03	0.03	0	0.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.01	0	0.02	0.01	0.02	0	0	0.04	0.03	0.03	0	0.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
17 – Minnove, Winston Lake Mine PR 0100	Days of Discharge	0.00	0.00	0.00	31.00	30.00	31.00	31.00	15.00	27.00	15.00	31.00	31.00	242
	Present Monthly Loadings, kg	0	0	0	0.1	0.07	0.12	0.18	0.04	0.14	0.04	0.07	0.08	0.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0.1	0.07	0.12	0.18	0.04	0.14	0.04	0.07	0.08	0.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0.1	0.07	0.12	0.18	0.04	0.14	0.04	0.07	0.08	0.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
19 – Dickenson, Arthur W. White Mine PR 0100	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	318
	Present Monthly Loadings, kg	242.00	547.28	279.12	0.00	1902.59	2172.88	2137.38	2214.19	1338.37	380.81	188.05	133.40	11531.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	81.12	182.36	84.55	0	904.58	1208.38	1156.1	1144.88	865.79	202.56	94.64	70.75	5815.7
	Reduction in Loadings	160.8783	364.9025	194.5728	0	998.0299	964.2848	981.2598	1069.314	850.5853	178.2517	91.4094	62.653	5716.1
	% Reduction	66.48	66.66	69.71	0.00	52.46	44.38	45.91	48.29	48.68	48.81	48.13	48.97	48.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	81.12	182.36	84.55	0	904.58	1208.38	1156.1	1144.88	865.79	202.56	94.64	70.75	5815.7
	Reduction in Loadings	160.8783	364.9025	194.5728	0	998.0299	964.2848	981.2598	1069.314	850.5853	178.2517	91.4094	62.653	5716.1
	% Reduction	66.48	66.66	69.71	0	52.46	44.38	45.91	48.29	48.68	48.81	48.13	48.97	48.6

Arsenic

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total/ Year
21 – Cenamax, Bell Creek Mine PR 0100	Days of Discharge	0	0	0	0	0	0	31	23	31	0	0	0	85
	Present Monthly Loadings, kg	0	0	0	0	0	0	18.83	9.64	13.46	0	0	0	38.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0	17.58	8.94	13.46	0	0	0	37.7
	Reduction in Loadings	0	0	0	0	0	0	1.0545	0	0	0	0	0	1.1
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	5.66	0.00	0.00	0.00	0.00	0.00	2.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.00	0.00	0.00	0.00	0.00	0.00	17.58	8.94	13.46	0.00	0.00	0.00	37.7
	Reduction in Loadings	0	0	0	0	0	0	1.0545	0	0	0	0	0	1.1
	% Reduction	0	0	0	0	0	0	5.66	0	0	0	0	0	2.7
24 – Teck – Corone, David Bell Mine PR 0100	Days of Discharge	25.00	6.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	264
	Present Monthly Loadings, kg	0.35	0.06	0	0.35	0.39	0.39	0.09	0.11	0.04	0.06	0.13	0.14	2.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.35	0.06	0	0.35	0.39	0.39	0.09	0.11	0.04	0.06	0.13	0.14	2.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.35	0.06	0	0.35	0.39	0.39	0.09	0.11	0.04	0.06	0.13	0.14	2.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
25 – Placer Dome, Detour Lake Mine PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.3	0.44	1.28	7.68	2.04	0.88	0	0.01	5.36	2.79	0.91	0.5	22.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.3	0.44	1.28	7.68	2.04	0.88	0	0.01	5.36	2.79	0.91	0.5	22.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.3	0.44	1.28	7.68	2.04	0.88	0	0.01	5.36	2.79	0.91	0.5	22.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
26 – Placer Dome, Dome Mine PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	5.00	23.00	331
	Present Monthly Loadings, kg	1.95	4.29	8.45	8.75	2.33	2.82	5.5	3.77	3.13	2.91	0.46	1.9	44.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.95	4.29	8.45	8.75	2.33	2.82	5.5	3.77	3.13	2.91	0.46	1.9	44.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.95	4.29	8.45	8.75	2.33	2.82	5.50	3.77	3.13	2.91	0.46	1.90	44.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
27 – Placer Dome, Dona Lake Mine PR 0100	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
	Present Monthly Loadings, kg	0	0	0	7.85	5.48	2.91	0	0	4.08	2.37	0	0	22.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	7.85	5.48	2.91	0	0	4.08	2.37	0	0	22.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	7.85	5.48	2.91	0	0	4.08	2.37	0	0	22.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
29 – Eastmaque Gold Mines PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.09	1.39	3.58	3.13	1.17	1.22	0.58	1.14	2.23	1.80	0.83	0.17	17.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.09	1.39	3.58	3.13	1.17	1.22	0.58	1.14	2.23	1.8	0.83	0.17	17.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.09	1.39	3.58	3.13	1.17	1.22	0.58	1.14	2.23	1.8	0.83	0.17	17.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
29 – Giant Yellowknife, ERG Res. PR 0100	Days of Discharge	0.00	0.00	27.00	0.00	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	40
	Present Monthly Loadings, kg	0	0	3.88	0	0	0	0	0	7.52	0	0	0	11.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	3.88	0	0	0	0	0	7.52	0	0	0	11.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	3.88	0	0	0	0	0	7.52	0	0	0	11.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
30 – Hemlo Gold Mines, Golden Giant PR 0100	Days of Discharge	0.00	0.00	0.00	0.00	0.00	16.00	31.00	30.00	31.00	30.00	31.00	19.00	188
	Present Monthly Loadings, kg	0	0	0	0	0	1.46	0.89	0.39	0.4	0.38	0.58	0.26	4.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	1.46	0.89	0.39	0.4	0.38	0.58	0.26	4.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	1.46	0.89	0.39	0.4	0.38	0.58	0.26	4.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
31 – Cenamax, Kremzar Mine PR 0100	Days of Discharge	0.00	0.00	16.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32
	Present Monthly Loadings, kg	0.00	0.00	0.23	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0.23	0.25	0	0	0	0	0	0	0	0	0.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0.23	0.25	0	0	0	0	0	0	0	0	0.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 – LAC Minerals, Macassa Division PR 0100	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
	Present Monthly Loadings, kg	0.23	0.67	1.37	29.35	1.02	1.33	0.44	0.24	0.63	1.64	1.04	0.36	38.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.23	0.67	1.37	29.35	1.02	1.33	0.44	0.24	0.63	1.64	1.04	0.36	38.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.23	0.67	1.37	29.35	1.02	1.33	0.44	0.24	0.63	1.64	1.04	0.36	38.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
35 – Cenamax, Merrill Mine MW 0100	Days of Discharge	0.00	31.00	0.00	0.00	30.00	31.00	31.00	30.00	31.00	0.00	31.00	31.00	246
	Present Monthly Loadings, kg	0	1.7	0	0	7.43	6.04	6.36	4.15	6.4	0	0.08	4.54	36.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	1.7	0	0	7.43	6.04	6.36	4.15	6.4	0	0.08	4.54	36.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	1.7	0	0	7.43	6.04	6.36	4.15	6.4	0	0.08	4.54	36.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
36 – American Barrick, McDermott PR 0100	Days of Discharge	0.00	11.00	27.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
	Present Monthly Loadings, kg	0	0.91	2.45	1.61	0	0	0	0	0	0	0	0	5.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0.91	2.45	1.61	0	0	0	0	0	0	0	0	5.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.91	2.45	1.61	0	0	0	0	0	0	0	0	5.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
37 – Bond Gold, Muskegsagagen Lake PR 0100	Days of Discharge	28.00	0.00	0.00	31.00	30.00	31.00	31.00	30.00	0.00	30.00	31.00	31.00	273
	Present Monthly Loadings, kg	0.01	0	0	0.09	0.1	0.03	0.04	0.01	0	0.06	0.01	0	0.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.01	0	0	0.09	0.1	0.03	0.04	0.01	0	0.06	0.01	0	0.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.01	0.00	0.00	0.09	0.10	0.03	0.04	0.01	0.00	0.06	0.01	0.00	0.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine MW 0100	Days of Discharge	28.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56
	Present Monthly Loadings, kg	2.54	1.53	0	0	0	0	0	0	0	0	0	0	4.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	2.54	1.53	0	0	0	0	0	0	0	0	0	0	4.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.54	1.53	0	0	0	0	0	0	0	0	0	0	4.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine PR 0200	Days of Discharge	0.00	0.00	0.00	10.00	28.00	31.00	31.00	30.00	17.00	0.00	0.00	0.00	148
	Present Monthly Loadings, kg	0.00	0.00	0.00	0.52	2.04	2.15	0.88	0.87	0.30	0.00	0.00	0.00	8.3
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0.52	2.04	2.15	0.88	0.87	0.3	0	0	0	8.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0.52	2.04	2.15	0.88	0.87	0.3	0	0	0	8.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
39 – Giant Yellowknife, Pamour #1 PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	15.00	31.00	30.00	0.00	21.00	309
	Present Monthly Loadings, kg	4.06	4.65	4.25	5.06	0.81	0.97	4.14	0.16	0.97	0.41	0	0.35	25.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	4.06	4.65	4.25	5.06	0.81	0.97	4.14	0.16	0.97	0.41	0	0.35	25.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	4.06	4.65	4.25	5.06	0.81	0.97	4.14	0.16	0.97	0.41	0	0.35	25.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
39 – Giant Yellowknife, Pamour #1 PR 0200	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
	Present Monthly Loadings, kg	0	0	0	0	0	0	0	0.13	0.51	0.04	0	0	0.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0	0	0.13	0.51	0.04	0	0	0.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0	0	0	0	0	0	0.13	0.51	0.04	0	0	0.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
42 – Renable Gold Mines PR 0100	Days of Discharge	0.00	14.00	0.00	28.00	28.00	30.00	1.00	5.00	0.00	0.00	0.00	0.00	104
	Present Monthly Loadings, kg	0.00	0.29	0.00	0.19	0.13	0.72	0.00	0.04	0.00	0.00	0.00	0.00	1.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0.29	0	0.19	0.13	0.72	0	0.04	0	0	0	0	1.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.29	0	0.19	0.13	0.72	0	0.04	0	0	0	0	1.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
45 – St. Andrews Gold Fields PR 0100	Days of Discharge	0	0	0	0	0	28	31	30	31	29	0	0	147
	Present Monthly Loadings, kg	0	0	0	0	0	0.27	0.11	0.16	0.86	0.59	0	0	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0	0	0	0	0.27	0.11	0.16	0.86	0.59	0	0	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.00	0.00	0.00	0.00	0.00	0.27	0.11	0.16	0.86	0.58	0.00	0.00	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
48 – Algoma Steel, Ore Division PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	180
	Present Monthly Loadings, kg	0.55	0.54	0.34	0.32	0.17	0.28	0	0	0	0	0	0	2.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.55	0.54	0.34	0.32	0.17	0.28	0	0	0	0	0	0	2.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.55	0.54	0.34	0.32	0.17	0.28	0	0	0	0	0	0	2.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property PR 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	2.48	33.16	32.01	43.08	30.13	22.13	21.24	23.65	28.34	25.56	23.64	2.43	267.6
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	2.48	33.16	32.01	43.08	30.13	22.13	21.24	23.65	28.34	25.56	23.64	2.43	267.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.48	33.16	32.01	43.08	30.13	22.13	21.24	23.65	28.34	25.56	23.64	2.43	267.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
51 – Denison Mines, Denison Property SW 0200	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	23.00	19.00	31.00	30.00	31.00	31.00	343
	Present Monthly Loadings, kg	0.01	0.02	0.08	0.02	0.02	0.04	0.01	0.01	0.03	0.04	0.08	0.02	0.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.01	0.02	0.08	0.02	0.02	0.04	0.01	0.01	0.03	0.04	0.08	0.02	0.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.01	0.02	0.08	0.02	0.02	0.04	0.01	0.01	0.03	0.04	0.08	0.02	0.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
52 – Rio Algom, Lacnor/Nordic SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.08	1	1.76	0.54	0.06	0.31	0.01	0.04	1	1.6	0.51	0.25	7.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.08	1	1.76	0.54	0.06	0.31	0.01	0.04	1	1.6	0.51	0.25	7.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.08	1	1.76	0.54	0.06	0.31	0.01	0.04	1	1.6	0.51	0.25	7.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel SR 0100	Days of Discharge	26.00	31.00	30.00	30.67	29.67	31.00	31.00	30.00	22.66	21.21	26.00	25.21	336.45
	Present Monthly Loadings, kg	0.91	1.15	1.08	1.00	0.83	1.16	0.83	0.80	0.51	0.42	0.52	0.61	10.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.91	1.15	1.08	1	0.83	1.16	0.83	0.8	0.51	0.42	0.52	0.61	10.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.91	1.15	1.08	1	0.83	1.16	0.83	0.8	0.51	0.42	0.52	0.61	10.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
54 – Rio Algom, Pronto SW 0100	Days of Discharge	0.00	12.00	29.67	31.00	28.25	0.00	11.00	0.00	0.00	0.00	21.00	0.00	132.92
	Present Monthly Loadings, kg	0	0.53	0.86	0.25	0.34	0	0.3	0	0	0	0.86	0	3.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0	0.53	0.86	0.25	0.34	0	0.3	0	0	0	0.86	0	3.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0	0.53	0.86	0.25	0.34	0	0.3	0	0	0	0.86	0	3.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
55 – Rio Algom, Quirke PR 0100	Days of Discharge	28.00	31.00	30.00	0.00	30.00	31.00	30.00	30.00	30.50	27.70	19.42	23.92	311.54
	Present Monthly Loadings, kg	1.08	2.12	2.82	0	2.86	0.98	0.95	0.7	2.13	2.1	1.33	1.09	16.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.08	2.12	2.82	0	2.86	0.98	0.95	0.7	2.13	2.1	1.33	1.09	16.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.08	2.12	2.82	0	2.86	0.98	0.95	0.7	2.13	2.1	1.33	1.09	16.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
56 – Cameco, Refinery, Blind River SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	20.00	0.00	0.00	0.00	22.00	0.00	31.00	31.00	224
	Present Monthly Loadings, kg	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.02	0.00	0.01	0.02	0.2
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.02	0.02	0.02	0.02	0.02	0	0	0	0.02	0	0.01	0.02	0.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.02	0.02	0.02	0.02	0.02	0	0	0	0.02	0	0.01	0.02	0.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0100	Days of Discharge	28	31	30	31	27	0	0	0	21	30	31	31	260
	Present Monthly Loadings, kg	2.7	3.09	2.44	3.41	2.4	0	0	0	0.74	3.26	2.66	2.39	23.1
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	2.7	3.09	2.44	3.41	2.4	0	0	0	0.74	3.26	2.66	2.39	23.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	2.70	3.09	2.44	3.41	2.40	0.00	0.00	0.00	0.74	3.26	2.66	2.39	23.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0200	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings, kg	1.48	0.34	0.38	0.38	0.28	0	0	0	0.02	0.15	0.29	0.64	3.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.48	0.34	0.38	0.38	0.28	0	0	0	0.02	0.15	0.29	0.64	3.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.48	0.34	0.38	0.38	0.28	0	0	0	0.02	0.15	0.29	0.64	3.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
57 – Cameco, Refinery, Port Hope SR 0300	Days of Discharge	28.00	31.00	30.00	31.00	27.00	0.00	0.00	0.00	21.00	30.00	31.00	31.00	260
	Present Monthly Loadings, kg	0.12	0.12	0.12	0.14	0.06	0	0	0	0.01	0.05	0.09	0.11	0.8
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.12	0.12	0.12	0.14	0.06	0	0	0	0.01	0.05	0.09	0.11	0.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.12	0.12	0.12	0.14	0.06	0	0	0	0.01	0.05	0.09	0.11	0.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Arsenic

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	*Total/ Year*
58 – Rio Algom, Stanleigh SR 0100	Days of Discharge	28.00	27.50	28.45	31.00	25.71	25.04	17.42	13.50	31.00	25.71	27.89	29.99	309.16
	Present Monthly Loadings, kg	1.74	1.58	1.21	1.89	1.62	1.4	0.79	0.54	1.49	1.11	1.94	2.13	17.4
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	1.74	1.58	1.21	1.89	1.62	1.4	0.79	0.54	1.49	1.11	1.94	2.13	17.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	1.74	1.58	1.21	1.89	1.62	1.40	0.79	0.54	1.49	1.11	1.94	2.13	17.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
59 – Denison Mines, Stanrock SW 0100	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
	Present Monthly Loadings, kg	0.3	0.21	0.59	0.14	0.01	0.13	0.1	0.02	0.14	0.37	0.56	0.1	2.7
	Loadings with Monthly Avg. Conc. Not Exceeding 0.5 mg/L	0.3	0.21	0.59	0.14	0.01	0.13	0.1	0.02	0.14	0.37	0.56	0.1	2.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 0.1 mg/L	0.3	0.21	0.59	0.14	0.01	0.13	0.1	0.02	0.14	0.37	0.56	0.1	2.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Cyanide Total

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Total Year
01 – INCO, Copper Cliff T.P.	Days of Discharge	29	31	30	31	30	30	31	30	31	30	31	31	364
PR 0100	Present Monthly Loadings, kg	67.29	82.63	51.12	38.49	17.37	12.77	10.84	17.08	42.66	34.84	96.14	119.94	591.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	67.29	82.63	51.12	38.49	17.37	12.77	10.84	17.08	42.66	34.84	96.14	119.94	591.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
02 – INCO, Crean Hill Mine	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	30.00	0.00	31.00	121
MW 0100	Present Monthly Loadings, kg	0	0	0	0	0.32	0	0	0.18	0	0.76	0	0.28	1.5
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0.32	0	0	0.18	0	0.76	0	0.28	1.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
03 – Falconbridge, Falconbridge	Days of Discharge	28.00	0.00	0.00	31.00	0.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	274
PR 0100	Present Monthly Loadings, kg	3.58	0	0	6.34	0	2.1	2.47	3.87	4.96	5.97	7.03	4.13	40.2
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	3.58	0	0	6.34	0	2.1	2.47	3.87	4.96	5.97	7.03	4.13	40.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
04 – INCO, Garson Mine	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	30.00	0.00	31.00	121
MW 0100	Present Monthly Loadings, kg	0	0	0	0	0.32	0	0	0.3	0	0.47	0	0.34	1.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0.32	0	0	0.3	0	0.47	0	0.34	1.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
05 – Noranda Minerals, Geco Division	Days of Discharge	28.00	21.15	29.25	30.29	29.90	29.87	20.19	29.04	30.57	29.17	29.89	30.04	338.46
PR 0100	Present Monthly Loadings, kg	0.14	0.11	0.19	0.19	0.17	0.18	0.72	1.04	1.21	1.19	22.57	8.93	34.6
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0.14	0.11	0.19	0.19	0.17	0.18	0.72	1.04	1.21	1.19	22.57	8.93	34.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
06 – Falconbridge, Kidd Creek Mine	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	30.00	0.00	0.00	90
MW 0100	Present Monthly Loadings, kg	0.00	0.00	0.00	0.00	2.78	0.00	0.00	3.08	0.00	3.08	0.00	0.00	8.9
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	2.78	0	0	3.08	0	3.08	0	0	8.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
07 – INCO, Levack Mine	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	0.00	31.00	31.00	122
MW 0100	Present Monthly Loadings, kg	0	0	0	0	0.33	0	0	0.13	0	0	1.13	0.34	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0.33	0	0	0.13	0	0	1.13	0.34	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
08 – Falconbridge, Lockerby	Days of Discharge	28.00	0.00	0.00	31.00	0.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	274
MW 0100	Present Monthly Loadings, kg	0.08	0	0	0.22	0	0.24	0.17	0.18	0.27	0.44	0.48	0.34	2.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0.08	0	0	0.22	0	0.24	0.17	0.18	0.27	0.44	0.48	0.34	2.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
09 – Falconbridge, Metallurgical	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	1078.90	2517.50	1908.84	1188.15	1305.15	1817.70	754.43	1464.38	1418.34	2715.85	2307.92	3846.23	22102.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	1003.89	2517.5	1908.84	1188.15	1305.15	1817.7	754.43	1177	1418.34	1360.25	1086.67	1132.22	16447.8
	Reduction in Loadings	76.2034	0	0	0	0	0	0	287.3842	0	1355.602	1221.249	2714.015	5654.5
	% Reduction	7.06	0.00	0.00	0.00	0.00	0.00	0.00	19.62	0.00	49.91	52.92	70.56	25.6

Cyanide Total

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
10 – INCO, Refinery, Sudbury SR 0100	Days of Discharge	0	0	0	0	30	0	0	30	0	30	0	31	121
	Present Monthly Loadings, kg	0	0	0	0	0.7	0	0	0.5	0	0.7	0	0.57	2.5
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0.7	0	0	0.5	0	0.7	0	0.57	2.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
11 – INCO, Nolin Creek T.P. SW 0100	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	30.00	0.00	31.00	121
	Present Monthly Loadings, kg	0	0	0	0	4.32	0	0	2.88	0	2.43	0	0.37	10.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	4.32	0	0	2.88	0	2.43	0	0.37	10.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
12 – Falconbridge, Onaping MW 0100	Days of Discharge	28.00	0.00	0.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	304
	Present Monthly Loadings, kg	0.14	0	0	0.17	0.19	0.27	0.22	0.3	0.21	0.36	0.35	0.32	2.5
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0.14	0	0	0.17	0.19	0.27	0.22	0.3	0.21	0.36	0.35	0.32	2.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
13 – INCO, Refinery, Port Colborne SR 0100	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	30.00	0.00	31.00	121
	Present Monthly Loadings, kg	0	0	0	0	1.61	0	0	1.57	0	1.37	0	1.66	8.2
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	1.61	0	0	1.57	0	1.37	0	1.66	8.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
14 – INCO, Shebandowan Mine PR 0100	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	30.00	0.00	31.00	121
	Present Monthly Loadings, kg	0	0	0	0	0.99	0	0	0.43	0	0.68	0	0.8	2.9
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0.99	0	0	0.43	0	0.68	0	0.8	2.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15 – Falconbridge, Strathcona PR 0100	Days of Discharge	28.00	31.00	30.00	30.00	27.00	31.00	31.00	0.00	0.00	16.00	23.00	31.00	280
	Present Monthly Loadings, kg	4.71	2.88	9.78	9.81	4.82	5.00	5.15	0.00	0.00	2.91	1.20	3.30	49.7
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	4.71	2.88	9.78	9.81	4.82	5	5.15	0	0	2.91	1.2	3.3	49.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
16 – INCO, Whistle Mine MW 0100	Days of Discharge	0.00	0.00	0.00	0.00	30.00	0.00	0.00	0.00	0.00	30.00	0.00	0.00	60
	Present Monthly Loadings, kg	0	0	0	0	0.04	0	0	0	0	0.21	0	0	0.3
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0.04	0	0	0	0	0.21	0	0	0.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
17 – Minnova, Winston Lake Mine PR 0100	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	27.00	0.00	0.00	0.00	42
	Present Monthly Loadings, kg	0	0	0	0	0	0	0	0.11	0.35	0	0	0	0.5
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0	0	0	0.11	0.35	0	0	0	0.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
18 – Dickenson, Arthur W. White Mine PR 0100	Days of Discharge	28.00	31.00	20.00	0.00	24.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	318
	Present Monthly Loadings, kg	24.35	87.75	82.85	0.00	713.60	203.18	75.24	91.40	243.67	132.07	30.37	17.82	1892.7
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	24.35	87.75	82.85	0	713.6	203.18	75.24	91.4	243.67	132.07	30.37	17.82	1892.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Cyanide Total

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
21 – Canamax, Bell Creek Mine	Days of Discharge	0	0	0	0	0	4	31	23	31	8	0	0	95
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0.62	4.48	2.57	21.09	10.82	0	0	39.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0	0.62	4.48	2.57	21.09	10.82	0	0	39.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
24 – Teck – Corone, David Bell Mine	Days of Discharge	25.00	6.00	0.00	27.00	30.00	31.00	23.00	30.00	11.00	20.00	31.00	30.00	264
PR 0100	Present Monthly Loadings, kg	33.1	4.63	0	14.4	1.49	1.43	1.69	5.64	1	4.61	4.67	9.33	82.6
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	33.1	4.63	0	14.4	1.49	1.43	1.69	5.64	1	4.61	4.67	9.33	82.6
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
25 – Placer Dome, Detour Lake Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	10.29	16.53	21.13	130.76	43.61	9.45	0.02	0.11	76.88	32.37	6.42	2.33	352.9
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	10.29	16.53	21.13	130.76	43.61	9.45	0.02	0.11	76.66	32.37	6.42	2.33	352.9
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
26 – Placer Dome, Dome Mine	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	5.00	23.00	331
PR 0100	Present Monthly Loadings, kg	20.31	45.96	1126.59	169.13	28.58	16.45	27.69	32.41	19.13	21.27	3.24	20.71	1532.5
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	20.31	45.96	1126.58	169.13	28.58	16.45	27.69	32.41	19.13	21.27	3.24	20.71	1532.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
27 – Placer Dome, Dona Lake Mine	Days of Discharge	0.00	0.00	0.00	25.00	30.00	27.00	0.00	0.00	31.00	30.00	0.00	0.00	143
PR 0100	Present Monthly Loadings, kg	0	0	0	2.83	5.26	2.25	0	0	6.96	4.7	0	0	22.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	2.83	5.26	2.25	0	0	6.96	4.7	0	0	22.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28 – Eastmeque Gold Mines	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	365
PR 0100	Present Monthly Loadings, kg	1.91	59.65	148.24	44.31	2.84	1.54	0.77	2.08	38.38	120.99	91.58	4.88	518.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	1.91	59.65	148.24	44.31	2.84	1.54	0.77	2.08	38.38	120.99	91.58	4.88	518.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
29 – Giant Yellowknife, ERG Res.	Days of Discharge	0.00	0.00	27.00	4.00	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	44
PR 0100	Present Monthly Loadings, kg	0	0	396.91	12.56	0	0	0	0	29.83	0	0	0	439.3
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	396.91	12.56	0	0	0	0	29.83	0	0	0	439.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30 – Hemlo Gold Mines, Golden Giant	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.00	18.00	50
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	0	0	0	0	0	18.25	14.76	33.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0	0	0	0	0	0	18.25	14.76	33.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
31 – Canamax, Kremzar Mine	Days of Discharge	0.00	0.00	16.00	16.00	0.00	8.00	0.00	16.00	0.00	0.00	0.00	0.00	56
PR 0100	Present Monthly Loadings, kg	0.00	0.00	9.47	2.27	0.00	1.88	0.00	6.66	0.00	0.00	0.00	0.00	20.8
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	9.47	2.27	0	1.88	0	6.66	0	0	0	0	20.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Cyanide Total

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total/ Year
		Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	
32 – LAC Minerals, Macassa Division	Days of Discharge	28	31	30	31	30	31	31	30	31	30	31	31	365
PR 0100	Present Monthly Loadings, kg	23.21	1360.54	330.09	5729	24.05	20.21	5.46	3.05	4.44	47.23	58.85	4.75	7631.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	23.21	174.84	274.71	5729	24.05	20.21	5.46	3.05	4.44	47.23	58.85	4.75	6370.0
	Reduction in Loadings	0	1205.598	55.3653	0	0	0	0	0	0	0	0	0	1261.0
	% Reduction	0.00	87.33	16.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.5
35 – Canamax, Merrill Mine	Days of Discharge	0.00	31.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	0.00	31.00	0.00	122
MW 0100	Present Monthly Loadings, kg	0	0.18	0	0	0.25	0	0	0.17	0	0	0.17	0	0.8
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.18	0	0	0.25	0	0	0.17	0	0	0.17	0	0.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
36 – American Barrick, McDermott	Days of Discharge	0.00	11.00	27.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54
PR 0100	Present Monthly Loadings, kg	0	3.2	6.39	4.1	0	0	0	0	0	0	0	0	15.7
	Losdings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	3.2	6.39	4.1	0	0	0	0	0	0	0	0	15.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
37 – Bond Gold, Muskegsegagan Lake	Days of Discharge	28.00	3.00	10.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	31.00	317
PR 0100	Present Monthly Loadings, kg	0.46	0.03	2	3.05	4.78	1.96	1.78	0.47	7.4	2.89	0.35	0.09	25.1
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0.46	0.03	2	3.05	4.78	1.96	1.78	0.47	7.4	2.89	0.35	0.09	25.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
38 – LAC Minerals, Williams Mine	Days of Discharge	0.00	28.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28
MW 0100	Present Monthly Loadings, kg	0	1.69	0	0	0	0	0	0	0	0	0	0	1.8
	Losdings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	1.69	0	0	0	0	0	0	0	0	0	0	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
38 – LAC Minerals, Williams Mine	Days of Discharge	0.00	0.00	0.00	10.00	29.00	31.00	31.00	30.00	0.00	0.00	0.00	0.00	131
PR 0200	Present Monthly Loadings, kg	0.00	0.00	0.00	40.69	61.62	27.02	27.26	19.59	0.00	0.00	0.00	0.00	176.2
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	40.69	61.62	27.02	27.26	19.59	0	0	0	0	176.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
39 – Giant Yellowknife, Pamour #1	Days of Discharge	28.00	31.00	30.00	31.00	30.00	31.00	31.00	15.00	31.00	30.00	0.00	21.00	309
PR 0100	Present Monthly Loadings, kg	618.61	141	31.26	13.32	6.26	1.23	1.84	0.31	0.45	0.61	0	1.33	816.2
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	81.79	141	31.26	13.32	6.26	1.23	1.84	0.31	0.45	0.61	0	1.33	279.4
	Reduction in Loadings	536.8223	0	0	0	0	0	0	0	0	0	0	0	536.8
	% Reduction	86.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.8
39 – Giant Yellowknife, Pamour #1	Days of Discharge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	31.00	5.00	0.00	0.00	61
PR 0200	Present Monthly Loadings, kg	0	0	0	0	0	0	0	3.38	15.45	0.33	0	0	19.2
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0	0	0	3.38	15.45	0.33	0	0	19.2
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
42 – Renable Gold Mines	Days of Discharge	0.00	14.00	30.00	28.00	28.00	30.00	1.00	5.00	0.00	18.00	0.00	0.00	152
PR 0100	Present Monthly Loadings, kg	0.00	4488.36	7928.20	2758.74	215.34	96.03	0.47	1.56	0.00	2.73	0.00	0.00	15490.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	488.75	976.78	247.84	128.82	96.03	0.47	1.56	0	2.73	0	0	1944.0
	Reduction in Loadings	0	3999.606	6951.418	2508.9	86.5235	0	0	0	0	0	0	0	13546.4
	% Reduction	0.00	89.09	87.68	91.01	40.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	87.5

Cyanide Total

Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg

		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	Total/ Year
45 – St. Andrews Gold Fields	Days of Discharge	0	0	0	0	0	28	31	30	31	29	0	0	147
PR 0100	Present Monthly Loadings, kg	0	0	0	0	0	2.35	1.15	0.47	10.62	7.83	0	0	22.7
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0	0	0	2.35	1.15	0.47	10.62	7.83	0	0	22.7
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
46 – Algoma Steel, Ore Division	Days of Discharge	0.00	31.00	0.00	31.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62
PR 0100	Present Monthly Loadings, kg	0	1.7	0	1.32	0	0	0	0	0	0	0	0	3.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	1.7	0	1.32	0	0	0	0	0	0	0	0	3.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
51 – Denison Mines, Denison Property	Days of Discharge	0.00	0.00	30.00	0.00	0.00	31.00	0.00	0.00	31.00	0.00	0.00	31.00	123
PR 0100	Present Monthly Loadings, kg	0	0	0.52	0	0	16.78	0	0	0.84	0	0	3.24	21.5
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0.52	0	0	16.78	0	0	0.84	0	0	3.24	21.5
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
51 – Denison Mines, Denison Property	Days of Discharge	0.00	0.00	30.00	0.00	0.00	31.00	0.00	0.00	31.00	0.00	0.00	31.00	123
SW 0200	Present Monthly Loadings, kg	0	0	0.01	0	0	0.01	0	0	0.01	0	0	0.01	0.0
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0.01	0	0	0.01	0	0	0.01	0	0	0.01	0.0
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
52 – Rio Algom, Lacnor/Nordic	Days of Discharge	0.00	31.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	0.00	31.00	0.00	122
SW 0100	Present Monthly Loadings, kg	0	0.17	0	0	0.04	0	0	0.01	0	0	0.17	0	0.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.17	0	0	0.04	0	0	0.01	0	0	0.17	0	0.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0
53 – Rio Algom, Panel	Days of Discharge	0.00	31.00	0.00	0.00	29.67	0.00	0.00	30.00	0.00	0.00	28.00	0.00	118.67
SR 0100	Present Monthly Loadings, kg	0.00	1.15	0.00	0.00	0.31	0.00	0.00	0.27	0.00	0.00	0.17	0.00	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	1.15	0	0	0.31	0	0	0.27	0	0	0.17	0	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
54 – Rio Algom, Pronto	Days of Discharge	0.00	12.00	0.00	0.00	28.25	0.00	0.00	0.00	0.00	0.00	21.00	0.00	61.25
SW 0100	Present Monthly Loadings, kg	0	0.09	0	0	0.06	0	0	0	0	0	0.29	0	0.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.09	0	0	0.06	0	0	0	0	0	0.29	0	0.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
55 – Rio Algom, Quirke	Days of Discharge	0.00	31.00	0.00	0.00	30.00	0.00	0.00	30.00	0.00	0.00	18.42	0.00	110.42
PR 0100	Present Monthly Loadings, kg	0	37.41	0	0	39.03	0	0	1.17	0	0	2.22	0	78.8
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	37.41	0	0	39.03	0	0	1.17	0	0	2.22	0	78.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
56 – Cameco, Refinery, Blind River	Days of Discharge	0.00	31.00	0.00	0.00	20.00	0.00	0.00	0.00	22.00	0.00	0.00	31.00	104
SR 0300	Present Monthly Loadings, kg	0.00	12.14	0.00	0.00	6.62	0.00	0.00	0.00	15.41	0.00	0.00	36.03	72.2
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	12.14	0	0	6.62	0	0	0	15.41	0	0	21.19	57.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	14.8356	14.8
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.18	20.5

Cyanide Total

		Present Monthly Loadings and Estimated Reductions in Monthly Loadings, kg												Total Year
		Feb–90	Mar–90	Apr–90	May–90	Jun–90	Jul–90	Aug–90	Sep–90	Oct–90	Nov–90	Dec–90	Jan–91	
57 – Cameco, Refinery, Port Hope	Days of Discharge	0	31	0	0	27	0	0	0	21	0	0	31	110
SR 0100	Present Monthly Loadings, kg	0	0.31	0	0	0.48	0	0	0	0.42	0	0	0.56	1.8
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.31	0	0	0.48	0	0	0	0.42	0	0	0.56	1.8
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
57 – Cameco, Refinery, Port Hope	Days of Discharge	0.00	31.00	0.00	0.00	27.00	0.00	0.00	0.00	21.00	0.00	0.00	31.00	110
SR 0200	Present Monthly Loadings, kg	0	0.03	0	0	0.06	0	0	0	0.01	0	0	0.04	0.1
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.03	0	0	0.06	0	0	0	0.01	0	0	0.04	0.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
57 – Cameco, Refinery, Port Hope	Days of Discharge	0.00	31.00	0.00	0.00	27.00	0.00	0.00	0.00	21.00	0.00	0.00	31.00	110
SR 0300	Present Monthly Loadings, kg	0	0.01	0	0	0.01	0	0	0	0.01	0	0	0.02	0.1
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.01	0	0	0.01	0	0	0	0.01	0	0	0.02	0.1
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
58 – Rio Algom, Stanleigh	Days of Discharge	0.00	27.50	0.00	0.00	25.71	0.00	0.00	13.50	0.00	0.00	27.86	0.00	94.57
SR 0100	Present Monthly Loadings, kg	0	0.28	0	0	0.27	0	0	0.18	0	0	0.85	0	1.4
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0.28	0	0	0.27	0	0	0.18	0	0	0.85	0	1.4
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
59 – Denison Mines, Stanrock	Days of Discharge	0.00	0.00	30.00	0.00	0.00	31.00	0.00	0.00	31.00	0.00	0.00	31.00	123
SW 0100	Present Monthly Loadings, kg	0	0	0.1	0	0	0.09	0	0	0.05	0	0	0.03	0.3
	Loadings with Monthly Avg. Conc. Not Exceeding 1.0 mg/L	0	0	0.1	0	0	0.09	0	0	0.05	0	0	0.03	0.3
	Reduction in Loadings	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	% Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0.0

The Hemlo Process

for

Wastewater Treatment

Appendix 14

of the

Development Document

THE HEMLO PROCESS FOR WASTEWATER TREATMENT

January 21, 1993

The Hemlo Process for Wastewater Treatment

1. General Description

The Hemlo Process for Wastewater Treatment is a three step process which removes, rather than oxidizes, free cyanide to form a stable precipitate. Metals such as arsenic, antimony, molybdenum and nickel are also effectively co-precipitated. Other forms of cyanides, namely cyanate and thiocyanate are removed during the cyanide destruction stage.

This process is currently in use at one known location, the Golden Giant Mine at the Hemlo gold mining camp in northwestern Ontario, where it has been effectively applied since 1988. A typical flowsheet of the Hemlo Process is shown in Figure 1.

2. Treatment Chemistry

An aqueous solution of cupric and ferrous sulphate is added to the wastewater at a controlled pH of 6 to 8. The following reaction is believed to occur in the "Pre-Mix" solution:

$$Cu^{++} + Fe^{++} + 3OH^{-} = Cu^{+} + Fe(OH)_3$$

This reaction does not necessarily proceed to completion. The ferrous ion, in the presence of hydroxide ions, is oxidized to ferric hydroxide while the cupric ion is reduced to its cuprous state. This reaction is virtually instantaneous.

Cuprous ion removes free cyanide as a stable precipitate of cuprous cyanide and creates a shortage of free cyanide ions in solution. Weak cyanide complexes, such as copper, zinc and nickel cyanides, dissociate into free cyanide and metal ions, leading to further removal of cyanide by the cuprous ions.

The simplified reaction for free cyanide removal is as follows:

$$2Cu^{+} + 2CN^{-} = Cu_2(CN)_{2\,(s)}$$

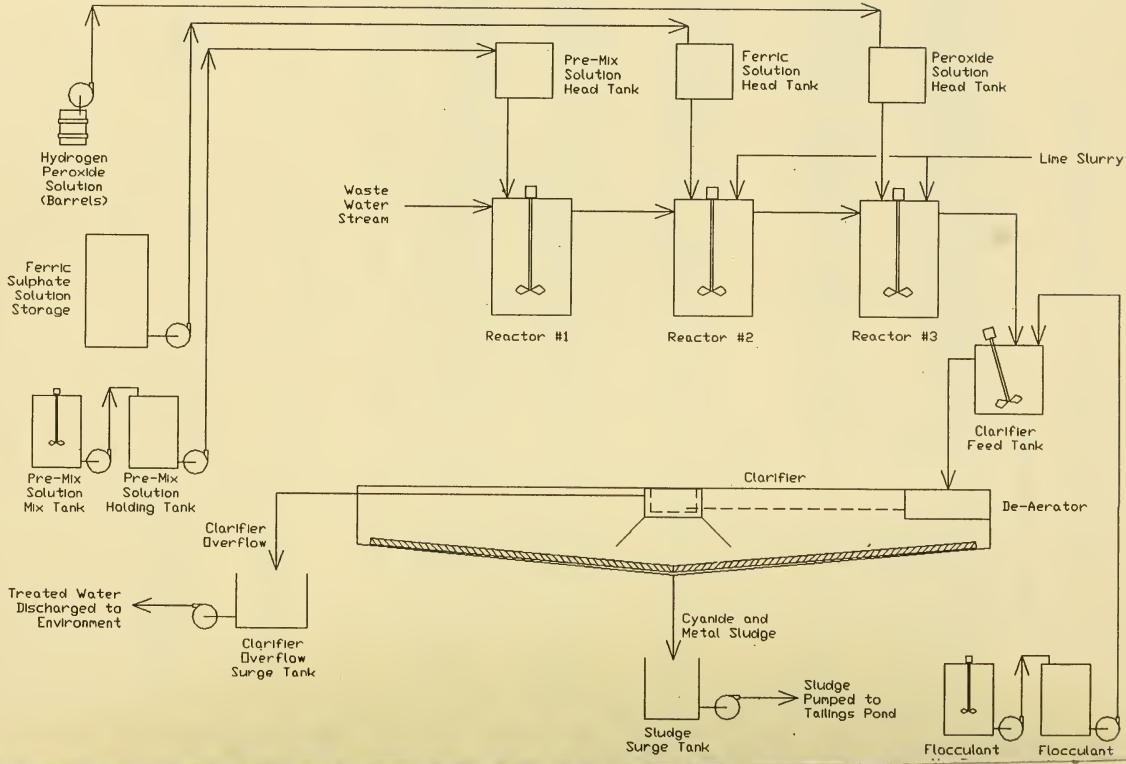
A typical example of the dissociation of metal-cyanide complexes follows:

$$Ni(CN)_4^{--} = Ni^{++} + 4CN^{-}$$

Ferrocyanide is believed to precipitate as cupric ferrocyanide immediately upon the addition of the "pre-mix" solution. The proposed reaction is:

$$2Cu^{++} + Fe(CN)_6^{4-} = Cu_2Fe(CN)_{6\,(s)}$$

Figure 1
Typical Flowsheet of the Hemlo Process
for Cyanide and Metal Removal



Thiocyanate is partially removed by the Hemlo Process according to the following reaction:

$$Cu^{+} + CNS^{-} = CuCNS_{(s)}$$

The demand of copper in this process is higher than that for other processes and is directly related to the concentration of cyanide in the influent stream. Plant experience indicates that a copper to cyanide ratio of 3:1 is sufficient to achieve effective treatment.

Heavy metals are co-precipitated from solution by the ferric hydroxide formed in the pre-mix solution and by supplementary addition of ferric ions in the ferric sulphate solution during the second stage of treatment. Due to the relatively high concentration of antimony, which is the major metal contaminant, the addition of supplementary iron is required year-round. The optimum iron to antimony ratio has been 10:1, although higher ratios contribute significantly to the stability of the sludge bed in the clarifier. Moderation of pH with lime slurry is required in the second stage to avoid pH excursions below 3.5. The nominal pH range in the second stage is 3.8 to 4.2.

The third and final stage of chemical treatment is the oxidation of free cyanide with hydrogen peroxide. This stage of treatment may be more economical than treating with pre-mix solution alone, although this should be determined on a case-by-case basis. The degree of natural degradation experienced in the tailings pond has a profound effect on the degree of chemical treatment required. This stage in the process also includes neutralization of the waste stream to pH 6.5 to 7.0 with the addition of lime slurry.

Following chemical treatment, flocculant is added to assist in the clarification stage. The waste stream enters the center well of a 32 metre diameter clarifier where the precipitates form a stable sludge. The depth of the sludge bed is carefully controlled and excess sludge is drawn from the center of the clarifier and pumped to the tailings pond for storage. Clarified water at less than 5 parts per million suspended solids overflows the clarifier is pumped to the evironment. Provisions have been made to allow the effluent to be pumped to the tailings pond during process upsets and routine maintenance.

3. Equipment Utilized

Copper: Bulk copper sulphate supplied in solid form and mixed with water for addition as solution.

Iron: Bulk ferrous sulphate supplied in solid form, mixed with copper sulphate and water to form "pre-mix" solution. Supplementary iron from ferric sulphate solution delivered in bulk form.

Hydrogen Peroxide:	Supplied in 35% solution in 205 litre barrels.
pH Control:	Slurry of hydrated lime and water.
Flocculant:	Anionic polymer supplied in solid form and mixed with water for addition as solution.
Reactors:	Currently using three woodstave vessels of 195 cubic metre capacity. Any vessel is suitable, provided that there is good agitation.
Clarifier:	Currently using one 32 metre diameter Enviroclear Clarifier. Must be capable of removing excess sludge formed during treatment stage.

4. Effluent Quality Control

Quality of the final effluent is based on several factors: retention time, copper to cyanide ratio, iron to antimony ratio, pH control, flocculant addition and sludge density. Retention time is based on equipment size and volumetric throughput. In the case at the Golden Giant Mine, the three reactors have 195 cubic metres of capacity each, giving a retention time of 0.65 hours per reactor at the design throughput of 300 cubic metres per hour.

Reagent addition rates are fixed based on routine analyses of the influent stream for total cyanide and antimony. A 3:1 ratio of copper to cyanide is used, while ratios of iron to antimony of 15:1 to 18:1 are used. As described above, a 10:1 iron to antimony ratio is sufficient for treatment purposes, but excess ferric sulphate contributes greatly to sludge stability.

Hydrogen peroxide addition is required only when the influent cyanide concentration is greater than 8 mg/L. Physical limitations of the pre-mix system and economic considerations dictate the use of peroxide.

Flocculant addition of 1.5 mg/L is required for adequate settling in the clarifier. Again, this is dependent on the sludge density and should be determined on a case-by-case basis.

Reagent flowrates, sludge bed depth, pH, lime addition rates and turbidity are measured on a continuous basis to ensure peak performance of the plant. Deviations in any of these parameters will trigger an alarm to the treatment plant operator who applies the necessary corrective action.

5. Effluent Quality

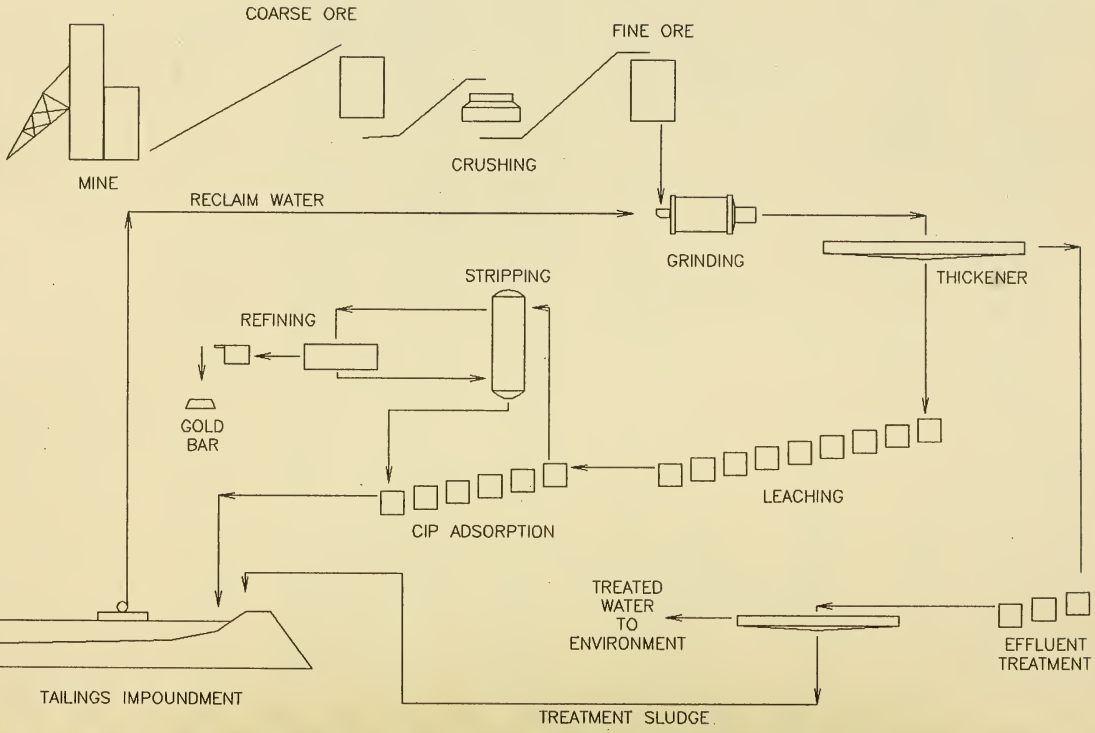
Typical influent and effluent quality data from operating records are tabulated below. Generally, cyanide levels below 0.2 mg/L are achieved during summer months, when full advantage of the natural degradation process in the tailings pond can be taken.

Parameter	Influent Concentration (mg/L)	Effluent Concentration (mg/L)
pH	8.0	7.5
Suspended Solids	40	2
Total Cyanide	3.5	0.240
Copper	0.100	0.055
Zinc	0.01	0.01
Nickel	0.15	0.12
Iron	0.85	0.32
Molybdenum	1.50	0.38
Arsenic	0.180	<0.002
Antimony	4.5	0.354
Mercury	<0.0001	<0.0001
Lead	<0.05	<0.05
Thiocyanate	11.0	8.0
Cyanate	3.0	2.0

In general, cyanide influent numbers peak in late winter at levels of about 8.0 mg/L and decrease to a minimum of 0.5 mg/L in late summer.

The Golden Giant Mine has been able to take advantage of some "pre-treatment" which occurs in the grinding circuit. While the mechanisms are not clear, it has been observed that approximately 50% of the total cyanide and an average 60% of the metals are reduced by utilizing tailings pond reclaim water in the grinding circuit. Excess grinding water, removed in the thickening stage, is passed through a series of carbon columns to remove residual gold and then fed to the Effluent Treatment Plant. Significant reductions in operating cost have been achieved with this unique configuration. The flowsheet is shown in Figure 2.

FIGURE 2
GENERAL MILLING PROCESS



6. Reagent Consumption and Operating Cost

The following table illustrates the average consumption rate per cubic metre of influent of each treatment chemical since 1988:

Reagent	Consumption Rate (g/m^3)
$CuSO_4$	12.0
$FeSO_4$	21.4
Fe in $Fe_2(SO_4)_3$	93.2
H_2O_2	30.2
Lime	125.4
Flocculant	1.5

The average copper to cyanide ratio was 3.5:1 while the average iron to antimony ratio (including iron in $FeSO_4$) was 16:1.

The average operating cost per 1000 cubic metres for reagents only is $250 for a yearly throughput of 2,100,000 cubic metres. This translates to about $0.48/tonne milled at the design milling rate of 1,092,000 tonnes per year. This cost does not include labour, electrical energy or maintenance.

The installation at the Golden Giant Mine utilizes the services of four full-time operators to man the plant 24 hours per day as well as one full-time tradesman for maintenance working 40 hours per week. Labour costs are $225,000 per year. Electrical costs are approximately $250,000 per year.

The total operating and maintenance cost is $479 per 1000 cubic metres, or $0.92 per tonne.

7. Capital Costs

Capital costs for the Hemlo Process is highly dependent on the capacity required and the influent characterisitics. Major capital items include: the building, 3 reactor tanks, 1 clarifier, a pipeline and access road to the receiver water, reagent receiving, mixing and distribution systems and the installation of pumps, instrumentation, furniture and other related equipment. The capitial cost for the plant described above is $6 million.

References

1. Konigsmann, E., Goodwin, E., and Larsen, C., 1989, "Water Management and Effluent Treatment Practice, Hemlo Gold Mines Inc., Golden Giant Mine". Presented at the Canadian Mineral Processors Conference, Ottawa, Ontario, January 17, 1989

2. Goodwin, E., 1987, "Process for the Removal of Cyanide, Arsenic, Antimony and/or Molybdenum Impurities from Solution", Canadian Patent Number 540430, June 23, 1987

Flow Control

Using

Vortex Valves

Appendix 15

of the

Development Document

Flow Control Using Vortex Valves

The Reg-U-Flo Vortex Valve is a product of H.I.L. Technology Inc.. Information on the product can be obtained from AER-O-FLO Environmental Inc. (1175 Appleby Line, Unit C-3, Burlington, Ontario, Canada; phone (416) 335-8944.

Vortex valves, with no external power requirements and no moving parts are inexpensive and can be used to protect waste treatment facilities or receiving watercourses from hydraulic surges. Being virtually maintenance free, they can provide an acceptable solution to flow regulation at both active and inactive mining sites.

The idea is simple: reduce flow to the downstream network by installing flow control devices at key points within the system which mobilize the storage volume inherent in upstream pipes manholes and surface terrain. Or to put it another way, ensure that maximum flow entering the sewer system does not exceed its capacity. For such a system to work, a self activating, economical, reliable flow control device which is easily installed into the existing drainage network to regulate the flow is required. Such a device exists - the Vortex Valve.

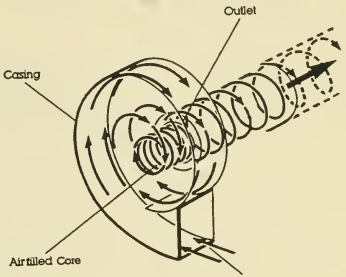
The design is simple. The valve consists of an intake, a volute, and an outlet. The flow is directed tangentially into the volute, generating high peripheral velocities that induce an air filled core with a resulting back pressure that reduces discharge. Units are custom designed for optimum performance, varying in size from a few inches to many feet in diameter. Typical flow rates range from as low as 0.05 cfs for an individual catchbasin control to 150 cfs for flow control at dams and rivers.

The Vortex Valve is superior to other flow control devices. Robustly fabricated of corrosion resistant stainless steel, it is totally self activating, has no moving parts, uses no external power, requires little or no maintenance, and lasts indefinitely. It has clear openings up to 400% larger than conventional flow regulators based on the same design criteria, greatly reducing the likelihood of blockage. Because of its unique three phase head discharge characteristic, it can reduce overall storage requirements by 30%, significantly reducing project costs.

Performance can be enhanced with a variety of accessories. The variable intake gate allows for modification of the unit's flow rate by up to 300% after installation, and the pivoting bypass door allows easy system draindown for maintenance purposes. Vortex suppressor pipes are also available to increase the flow by up to 50% with a very small increase in head.

The Vortex Valve's effectiveness has been proven in over 7,500 installations worldwide. Its unique capabilities can be applied to any situation where flow control is required. Other applications include storage facilities to control outflow, treatment plants to control the hydraulic load, flow balancing , inlet control,

catchbasin control, downspout control, irrigation, flow splitting, drop shaft control, land drainage control, and control of compensation water and outlets from dams.



Vortex Flow Pattern

The advantages of the Vortex Valve from both a technical and economic standpoint are significant. For example, if the requirement is to restrict the flow to 1.35 cfs (38 l/s) under a head of 9 ft (2.75 m) the solutions could be:

1. 1 No. 8" (200 mm) Type SH Reg-U-Flo Vortex Valve.

2. 1000 ft (305 m) of 8" (200 mm) diameter throttle pipe laid level.

3. 1 No. Gate Valve screwed down to 1.4" (36 mm) above invert.

4. 1 No. 4" (100 mm) diameter orifice plate.

The area of flow on the Vortex Valve is four times larger than the equivalent orifice plate. The Vortex Valve not only offers a large area of flow, but is easily maintained when compared with conventional devices.

Advantages of the Vortex Valve:

1. No external power requirement.
2. No moving parts.
3. Totally self activating.
4. Robust stainless steel construction.
5. Outlet openings up to 400% greater than conventional controls.
6. Virtually maintenance free.
7. Simple to install.
8. Reduced capital costs.
9. Individually designed.
10. Versatile.
11. Short delivery time.
12. Proven track record.

Concerns

of the

MISA Advisory Committee

Appendix 16

of the

Development Document

CONCERNS OF THE MISA ADVISORY COMMITTEE

The MISA Advisory Committee is a panel of qualified professionals and environmentalists that was established to provide an opinion to the Minister of Environment and Energy on MISA regulations developed by the joint efforts of industry and various levels of government.

In June of 1993, the MISA Advisory Committee commented on the proposed Metal Mining Effluent Limits Regulation. Comments made by the Committee and a response for each follow:

COMMENT: RADIOACTIVE SUBSTANCES

The MISA Advisory Committee recommended that the Regulation be expanded to include limits for radioactive substances of concern

RESPONSE:
All uranium mines and refineries in Ontario are covered by Atomic Energy Control Board licences that limit radioactive substances of concern. On July 21, 1993, legal staff of the Ministry of Environment and Energy again confirmed the legal opinion that the federal Atomic Energy Control Board is exclusively responsible for "atomic energy" under the Atomic Energy Control Act. In addition, the MISA regulations are based on data collected over a period of a year under effluent monitoring regulations. These regulations did not address radioactive substances. Notwithstanding the above, there has been no consultation with the Atomic Energy Control Board, Environment Canada or industry concerning the incorporation of limits for radioactive substances into MISA regulations. As a consequence, limits for radioactive substances do not appear in the MISA Metal Mining Effluent Limits Regulation

COMMENT: NUMBER OF OPERATING MINES EXCLUDED FROM THE REGULATION

The MISA Advisory Committee asked if some operating metal mines were exempt from the Regulation

RESPONSE:

All known operating metal mines in Ontario are covered by the Regulation.

COMMENT: CHEMICAL OXYGEN DEMAND AND PHENOLICS

The MISA Advisory Committee expressed concern that chemical oxygen demand (COD) and phenolics were not limited in the regulation

RESPONSE:

Chemical oxygen demand was not found at all properties and where it was found, the average concentration was 23 milligrams per litre (the Regulation Method Detection Limit is 10 milligrams per litre). Ontario metal mining wastes are predominantly inorganic in nature and are generally held in contact with the atmosphere for weeks or months before being released to the environment. This allows components of the waste that contribute to COD to degrade naturally. Specific economic technology for reducing COD in the metal mining sector was not found by the sector consultant during a world-wide search for technology. Because of the relatively low levels of COD encountered in Ontario metal mining effluents and because the COD of metal mining effluents on a world-wide basis was not identified by the sector consultant or by the Joint Technical Committee as a significant environmental concern, COD was not considered for limits setting. The Regulation, however, can be amended or a suitable control instrument such as a control order can be issued to resolve difficulties involving COD on a site-specific basis.

The average concentration of phenolics found (as measured by the 4-aminoantipyrine test) in effluents in the metal mining sector was 5 parts per billion (the Regulation Method Detection Limit is 2 parts per billion). The 4-aminoantipyrine test is a colorimetric test that is routinely used to detect hydroxybenzene compounds (phenolic compounds) in aqueous samples. The test has a limited capability to accurately measure the actual (true) concentration of phenolic compounds in aqueous samples. In fact, many of the forms of phenolics are inadequately measured or are not detected at all by the test.

Phenolic compounds can be of natural or man-made origin. In addition to their production and/or use by industry, a wide variety of phenolic compounds can be formed in nature as minor constituents of essential oils (odoriferous oily products of plant origin). Naturally occurring phenolics can also be formed through the decomposition of plant matter.

The range of aquatic toxicity for phenolic compounds is very wide. Some phenolic compounds are toxic at less than one part per million while the toxicity of others exceeds several hundred parts per million.

Phenolic speciation is a test method used to identify individual phenolic compounds in aqueous samples. The 4-aminoantipyrine test does not speciate phenolics. To effectively evaluate the potential environmental effects of phenolic compounds, it is necessary to identify the individual phenolic species that may exist in an effluent.

While there is no doubt that limited quantities of substances that

contain phenolics are used by the Ontario metal mining industry on a case-by-case basis, there is equally no doubt that substantial amounts of the phenolics detected in Ontario metal mining effluents have a natural origin. Runoff from heavily forested and swampy areas commonly gains access to tailings areas and mine workings.

In addition to the questionable environmental significance of the results of the 4-aminoantipyrine test in the metal mining sector, specific practicable technology for the removal of phenolics from Ontario metal mining sector effluents could not be identified by the Joint Technical Committee or by the sector consultant.

Because of the low levels (average: 5 parts per billion) of phenolics detected in metal mining sector effluents and because of the environmental uncertaintly associated with the results of the 4-aminoantipyrine test and the fact that demonstrated practicable technology for the removal of phenolics from metal mining sector effluents was not be found, phenolics were not considered for effluent limits setting.

COMMENT: THE RECOMMENDED LIMITS FOR LEAD AND ARSENIC ARE HIGHER THAN THE COMPUTER CALCULATED VALUES

RESPONSE:

The levels of lead and arsenic in most Ontario metal mining effluents are very low and, as a consequence, calculated values for monthly and daily limits are low when all sector plants are included in the database. In the case of lead, the calculated values for monthly and daily limits were 0.03 and 0.07 milligrams per litre. Because of these low levels on an industry-wide basis, most members of the Metal Mining Joint Technical Committee recommended the elimination of lead as a limited parameter in the proposed regulation. The Ministry, however, pointed out that while lead levels were generally low in Ontario metal mining effluents, some properties that mine large quantities of lead and some properties that use cyanide (which dissolves lead) contained lead values in their effluents higher than those indicated by the calculated monthly and daily limits. As a consequence, the Joint Technical Committee agreed to limit lead in the regulation but were constrained by the fact that demonstrated economic technology for the removal of lead in effluents at these properties could only achieve 0.2 milligrams per litre of lead. This level was adopted as the basis for the lead limits. A similar situation existed for arsenic in that the low values for monthly and daily limits that were calculated for the sector as a whole were exceeded at a small number of gold and base metal properties. Demonstrated economic technology for these properties could only achieve 0.5 milligrams per litre of arsenic and is used by the Ministry at Deloro. This level was adopted as the basis for the arsenic limits in the regulation.

COMMENT: THE REGULATION MAINTAINS EXISTING LEVELS OF PERFORMANCE

The MISA Advisory Committee suggested that the regulation was developed based on the average performance of existing mines in the Province and because the majority of these mines are judged to be already at best available technology levels, no significant improvement in the environment can be expected as a result of the regulation

RESPONSE:

Appendix 13 of this document clearly states the loadings reductions that can be expected to occur as a result of the application of the regulation to Ontario metal mining plants. These loadings reductions are based on conservative calculations and are as follows:

Suspended Solids	23%
Copper	36%
Nickel	35%
Zinc	50%
Arsenic	44%
Cyanide	40%

These loadings reductions are based on meeting the numerical limits stated in the regulation. In fact, all technologies will have to be operated at levels well below the stated numerical limits in order to be in compliance on a full-time basis. As a consequence, loadings reductions are expected to be larger than those stated above.

In addition, the limits in the regulation are more stringent than existing Ministry mining guidelines. Concentration compliance limits will be reduced by 50% for cyanide, 70% for copper, 80% for lead, 50% for nickel and 50% for zinc. Compliance levels for suspended solids (currently the most stringent in the world in metal mining) and for arsenic (due to a lack of economic technology) will numerically remain the same but in regulation rather than guideline form. Compared to existing Ministry guidelines, the regulation will narrow the required pH range from 5.5 - 10.6 to 6.0 -9.5 .

As a set, the limits (including the requirement for non-toxic effluents) are the most stringent of any metal mining jurisdiction world-wide.

COMMENT: WATER CONSERVATION AND RECYCLE ARE NOT ADEQUATELY ADDRESSED IN THE REGULATION

RESPONSE:

Wastewater recycle has been one of the highest environmental priorities of the metal mining sector since 1971. In general, plants within the sector practice up to 85% recycle. Efforts to increase the rates of recycle at many plants are now limited by the imbalance on the systems imposed by natural precipitation. The sector consultant's report states (section 10-2) that the net annual surplus of precipitation less evaporation in Ontario varies from 200 to 500 millimetres and that "zero volume discharge" as practiced in drier climates using natural evaporation is not possible in Ontario. The consultant also stated that "zero volume discharge" in Ontario could only be achieved in most cases using fuel assisted evaporation of plant effluents. This (development) document concludes that fuel assisted evaporation of plant effluents in this sector in Ontario is uneconomical. The industry continues to look for ways to increase wastewater re-use on a site-specific basis.

Given the annual surplus of precipitation in Ontario, 100% recycle (zero volume discharge) appears to be possible at most sites only if:

- mining and milling operations are suspended
- fuel assisted evaporation of effluents is implemented
- some unit operations at a plant site that require water are replaced by operations that do not use water

Dry processing of ores is theoretically possible but a significant investment in time, money, research, development, piloting and full-scale demonstration operations is required. Care must be taken to ensure that difficulties with wastewater control are not exchanged for equally difficult challenges in air pollution or noise level control.

COMMENT: AMMONIA

The MISA Advisory Committee indicated that the regulation does not address ammonia despite the fact that ammonia is known to be present in most mine effluents, often at toxic levels, and despite the fact that technology is not only known but is widely used in other sectors.

RESPONSE:

The test for ammonia used in the metal mining sector actually measures "ammonia plus ammonium". "Ammonia plus ammonium" was found in all of the metal mining effluents sampled. The average concentration measured was 1.4 milligrams per litre in base metal mining effluents and 6.3 milligrams per litre in gold mining effluents (the Regulation Method Detection Limit is 0.25 milligrams per litre). However, at the time of the MISA effluent monitoring program for the metal mining sector, two base metal mines and four gold mines generated effluents that contained in excess of ten

milligrams per litre of "ammonia plus ammonium". While there is no "hard" rule for toxicity due to "ammonia plus ammonium" in the Ontario metal mining sector, generally, levels of "ammonia plus ammonium" that are less than 5 milligrams per litre do not give rise to significant effluent toxicity; levels between 5 and 10 milligrams per litre sometimes give rise to lethal effluents and levels in excess of 10 milligrams per litre almost always give rise to lethal effluents.

In the metal mining sector, the use of (anhydrous) ammonia for pH control or for metals precipitation has been largely discontinued. All metal mines, however, normally use explosives. The explosives that are in routine use all contain ammonium nitrate. The most common explosive in use in Ontario is ANFO which is 95% ammonium nitrate. Water gel explosives contain 60 to 80% ammonium nitrate and nitroglycerine-based explosives contain 40% ammonium nitrate. Minor amounts of explosives are spilled during use or do not take part in an explosion. Ammonium nitrate is highly soluble in water. The geology, mining method and conditions in a mine determine the type of explosive that can be used in any particular circumstance. Safety is always a factor in the selection of an explosive. Explosives containing smaller amounts of ammonium nitrate can sometimes be substituted for explosives containing higher amounts of ammonium nitrate. In many cases, however, substitution is simply not practicable or is not possible due to wet conditions underground.

A limit for "ammonia plus ammonium" does not appear in the metal mining regulation because demonstrated economic technology could not be found for the treatment of this substance in the sector. The economic technology for ammonia treatment that is available in other industrial sectors, in general, applies to relatively high concentrations of ammonia in relatively low volume flows rather than to the low ammonia concentrations and high volume flows that tend to characterize the metal mining sector.

The control of "ammonia plus ammonium" in metal mining sector effluents is recognized by the industry as one of their most important environmental challenges. As a consequence, the federal government and the industry have formed an "ammonia consortium" in an attempt to find solutions to the ammonia treatment difficulties that face the industry. If suitable technology is found, the regulation can be amended to reflect the treatment that has become available.

COMMENT: POTENTIAL FOR CROSS-MEDIA CONTAMINATION

The MISA Advisory Committee suggested that, because of the extensive use of open settling ponds and water-borne transport of tailings, the metal mining sector has a high potential for the transport of pollutants across media

RESPONSE:

The Ministry recognizes that the metal mining sector has a potential for transfer of pollutants across media. The extensive use in the industry of settling ponds that have surface areas of several square kilometers suggests that transfer of pollutants from the wastewater to the air is always a possibility. However, when and where possible, the ponds are operated in a manner that minimizes the volatilization of substances such as cyanide (when cyanide is known to be present, the ponds are kept in an alkaline condition to prevent the formation of cyanide gas). In addition, the use of certain technologies such as floating aerators has sometimes been discouraged since the function of these devices could be to strip organics from the wastewaters and to blow these substances (when they are present) into the atmosphere.

COMMENT: OIL AND GREASE IS NOT LIMITED IN THE REGULATION

RESPONSE:

The parameter known as "oil and grease" was found in more than half of the metal mining sector effluents that were sampled. The average concentration of "oil and grease" measured in the effluents was 1.1 milligrams per litre (the Regulation Method Detection Limit is 1 milligram per litre). At many properties, however, occasional peaks averaging 13 milligrams per litre were recorded.

The sources of "oil and grease" in Ontario metal mines are well known. Some "oil and grease" may be of natural origin and result from the decay of vegetation on the property. However, the main sources of the "oil and grease" appear to be the oils and greases that are used on a routine basis at most mining operations in conjunction with mine/mill machinery and vehicles.

"Oil and grease" in the metal mining sector is largely found floating on the surface of effluents. Emulsions are not common.

Economic technology is available for the removal of floating oils and greases from metal mining effluents. Baffled sumps, baffled settling ponds and baffled tailings ponds are in common use in the industry and these uses will continue. Oil and grease are skimmed from the sumps and other treatment devices when and where necessary. Recovered waste oil may be re-used on a mining property or it may be sent to a refiner of waste oils.

In the metal mining sector, there are substantial difficulties that involve the sampling and analysis of "oil and grease". With most "oil and grease" floating on the surface of effluents, it is very difficult to prove that any sample taken is actually representative of an effluent.

During the MISA effluent monitoring period for the metal mining

sector, private laboratories contracted by the mining companies tended to use Freon to recover "oil and grease" from sector effluents. The use of Freon is being phased out. Various environmental agencies are currently evaluating a number of different solvents for use in the test. Each solvent, including those currently in use, tends to extract "oil and grease" with an efficiency or at a rate that is peculiar to that particular solvent. As a consequence, "oil and grease" test results for a specific effluent tend to differ depending on the type of solvent used. The metal mining Joint Technical Committee concluded that the sampling and analytical procedures that are currently available for "oil and grease" are controversial and are unlikely to consistently produce results that would accurately reflect the true nature of sector effluents. As a consequence, "oil and grease" was not considered for effluent limits setting.